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GUIDELINES FOR VARIABLE MESSAGE SIGNS

(First Revision)

INDIAN ROADS CONGRESS

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ABBREVIATIONS

HTTPS	Hypertext Transfer Protocol Secure
SFTP	Secure File Transfer Protocol
API	Application Program Interface
ATCC	Automatic Traffic Counter and Classifier
ATMS	Advanced Traffic Management System
CCC	Command Control Center
CCTV	Closed Circuit Television
CMS	Changeable Message Sign
CPU	Central Processing Unit
DIP	Dual In-line Package
DMS	Dynamic Message Sign
ECB	Emergency Call Box
EVM	Emergency Vehicle Management
FAT	Factory Acceptance Test
FM	Frequency Modulation
FRC	Flat Ribbon Cable
GFC	Good For Construction
GIS	Geographical Information Systems
GPS	Global Positioning System
HDPE	High Density Polyethylene
IP	Internet Protocol
IT	Information Technology
ITMS	Information Technology Management Services
ITS	Intelligent Transport Systems
LAN	Local Area Network
LED	Light Emitting Diode
LDR	Light Dependent Resistor
MCB	Miniature Circuit Breaker

NTCIP	National Transportation Communications for Intelligent Transportation Syster Protocol
NTIC	National Traffic/Transportation Information Center
OEM	Original Equipment Manufacturer
OPT	Operations Performance Test
PMPP	Point to Multi Point Protocol
PMU	Power Management Unit
POP	Proof of Performance
PPP	Point-to-Point Protocol
PSA	Public Service Announcements
QAP	Quality Assurance Plan
RAM	Random Access Memory
RCC	Regional Control Centre
ROC	Regional Operations Centre
SAT	Systems Acceptance Test
SFAT	Software Factory Acceptance Test
SIT	System Integration Test
SMD	Surface Mounted Devices
SMPS	Switched Mode Power Supply
SMS	Short Message Service
SSO	Single Sign-On
TMC	Traffic Management Centre
TRL	Transport Research Laboratory
UDP	User Datagram Protocol
UPS	Un-interrupted Power Supply
VIDS	Video Incident Detection System
VMD	Variable Message Display
VMS	Variable Message Signs
VSS	Variable Signs and Signals
WIP	Work Inspection Report

GUIDELINES FOR VARIABLE MESSAGE SIGNS

1. INTRODUCTION

The guidelines related to Variable Message Signs will assist the road authorities in taking decisions regarding the installation of VMS and display of dynamic information related to variable situations to the motorists in an orderly and consistent manner. The VMS system so established is not intended to be 'one-off' or 'stand-alone' system but 'scalable', so that its resources are seamlessly shared with as many projects as technically and economically feasible and eventually form part of an ITS system. The guidelines will cover the messages to be conveyed on account of four 'user services', viz., traveler information, incident management, emergency management and traffic management at project level by erecting Variable Message Signs, which can, in future, be integrated with several other similar projects and expanded to cover several other user services to eventually form part of an Intelligent Transport System (ITS).

Variable Message Signs (VMS) (also known as Changeable Message Signs, CMS or Dynamic Message Signs, DMS) are special Road Signs. Compared to fixed road signs, VMS delivers dynamic information 24x7, 365 days in a year. These communicate the real time information thus indicating the prevailing condition on the road. This information set shall include the location where the reported condition is likely to be encountered, and the action traveler shall take to avoid the possible hazard. The information flow and guidance to the travelers by the road owning authority falls under 'user service' and is called 'Traveler Information Service'. 'Traveler Information Service' will work effectively only if the traveler is informed as soon as the hindered condition is intervened manually or technologically and brought to the acceptable condition. This means 'Traveler Information Service' must be combined with an 'Incident Management Service' and 'Emergency Management Service'.

Examples of traveler information provided through VMS include:

- Travel time between known destinations
- Congestion conditions along a high-speed corridor
- Construction site warning/information notices
- Special event notice and motorist instructions
- Maintenance operations schedule
- Severe weather announcement
- Incident or accident notification

Besides, there are many other transportation-related user services such as toll management, fleet management, transit management, multimodal transportation management, commercial vehicle fleet management, information service management, archived data management, which would be of interest to different users of the transportation system. These services also, in addition to the four services described above, may have to be integrated within a system, the

Intelligent Transport System (ITS), to provide on-line services of various kinds to different users across the nation.

VMS can be used as a valuable and effective traffic control device used to provide motorists enroute traveler information. The information is most often displayed in real-time and can be controlled either from a remote centralized location or locally at the site. VMS are designed to modify motorist behaviour to improve traffic flow and operations. Traveler information displayed on VMS may be generated because of a planned or unplanned event, which is programmed or scheduled by operations personnel. They are commonly installed on full-span overhead sign bridges, post-mounted on roadway shoulders, overhead cantilever structures or portable types mounted on trailers/ prime-mover. The objective of providing the information is to give travel directions and to enable the motorist adequate time to avoid an incident or prepare for unavoidable conditions. For all information displayed, the goal is to have a positive impact on the motorist's travel time.

Unacceptable traffic conditions on road may occur due to congestion, break down flow (stop-start condition), turbulence, over speeding, and unsafe or dangerous maneuvers (lane change, merging, weaving, overtaking, sudden acceleration/deceleration, evasive actions, etc.). These will cause inconvenience and delay to the travelers, and lack of overall safety and efficiency in transportation. Many of these can be omitted through traffic management measures (e.g., diverting traffic from congested exits to relatively free exits, metering the entry flow or diverting it to next entry, detecting over speeding vehicles and advising them for speed compliance, prohibiting/permitting certain maneuvers for safety, etc.). The associated measure shall be communicated to the travelers through VMS. Thus, 'Traffic Management Service' is another 'user service', which can be provided through VMS.

Similar to fixed road traffic signs or other traffic control devices, aspects like legibility, credibility and reliability of the message are critical. Without these basic requirements, even the best message will go unheeded. Care must be taken not to display a message that the motorists will not understand, disregard or will discover to be incorrect. These are important as signs are the primary channels of communication to the motorists.

The authority procuring the VMS system for a project is strongly advised to make sure that the items listed below are either (i) already in place or (ii) made part of the procurement or (iii) likely to be in place before 'beta testing' of the VMS system.

a) Road Sensors – types and numbers (to be) installed and their location on the project road

b) The communication link (to be) established between each sensor controller and the TMC Ethernet and that between TMC Ethernet and each of the VMS controllers

c) TMC infrastructure including facilities and fixtures (to be) placed and their location

d) The layout, hardware, software, and connectivity (to be made) available for the local TMC network

e) The nodal authority in the response organisations, the communication link between them and the TMC and the protocol of intervention on road.

Simultaneously, the requirements such as system components and their physical and communication interconnects, the communication system requirements, the standards for communication protocols, devices and equipment, the issues relating to interchangeability, interoperability, and vendor neutrality of the devices also need to be taken into consideration before finalizing the VMS system.

IRC:SP:85 was first published during the year 2010. However, due to major changes in traffic conditions over two decades, a need was felt to revise these guidelines. The Transport Planning and Traffic Engineering Committee (H-1) of IRC took up this task of revision and a subgroup comprising Dr. Rajat Rastogi (Subgroup Chairman), Shri Venkata Subbarao Chunduru, Shri Swatantra Kumar and Shri S.S. Khandelwal was constituted. The draft prepared by the subgroup was deliberated in various meetings of H-1 Committee and was finalized in its meeting held on 13.09.2022.

The composition of H-1 Committee is given below:

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The revised draft document was placed before the Highways Specifications and Standards Committee (HSS) in its meeting held on 24.09.2022. The HSS Committee approved this draft revision subject to suitably incorporating written and verbal comments received and also recommended it for placing before the meetings of Executive Committee (EC) and Council. The EC in its meeting held on 07.10.2022 approved the draft revision for placing before the Council. The 223rd Council in its meeting held on 8th October, 2022 at Lucknow (Uttar Pradesh) considered and approved draft revision of IRC:SP:85 "Guidelines for Variable Message Signs" for printing.

2. DEFINITIONS

Accident – Unforeseen and undesirable event particularly related to vehicles in which a hazard is created for road users, includes spillages, vehicle breakdowns, collisions, or fires.

Backing-Board – The surround to the VMS, used depending on local circumstances, providing improved visibility of the VMS by means of broadening its size and by providing suitable visible contrast with the VMS background.

Capacity – Maximum number of vehicles that can pass a reference line or a uniform section of a road in one hour under the prevailing road, traffic, and control conditions.

Confirmed Report – An accident or incident reported by someone who is a trusted source of information.

Controller – Device which is used to control the VMS operations.

Unconfirmed Report – An accident or incident reported by anyone other than an agreed approved source.

Cantilever Support – Support system with a single post and a cantilever arm supporting VMS(s) mounted over the traffic lane.

Control Device – Equipment used to execute a change of message other than by purely manual means.

Emergency Management Services – Services which deals with the risks and avoidance of risks.

Journey Time – The travel time between two locations at specific times of the day.

Congestion – This is the state of vehicular flow in which the travel time increases highly between the two points and driving stress occurs.

Delays – Travel time above the journey time at a time in a day.

Display Surface – The visible part of a VMS that contains the elements that may be activated to display the message.

Element – The basic visual light emitting and/or reflecting object or cluster of objects in the display surface of a VMS, activated in conjunction with other elements to form the desired message.

Fixed Signs – These are the signs which are embedded at a location and cannot be moved as per requirement.

Fixed VMS – Variable Message Signs which are placed at locations requiring continuous flow of information to the road users. These are fixed at a location.

Front Panel – The visible part of a sign comprising the display surface; and the backing-board when this is integrated in the front of the VMS.

Front Screen – A screen protecting the display surface or the parts of it against dust, water, etc.

Gantry – Support system spanning a carriageway with one or more posts on each side of the carriageway supporting VMS mounted over the traffic lanes.

Gap (in VMS infrastructure) – A section of road, where a significant distance exists between permanently located VMS.

Incident – An event which impacts the smooth flow of traffic on the road. E.g. a security threat, an unexpected weather condition,fire on a vehicle, crash, or a police-led incident.

Incident Management Services – These are the part of Information Technology Management Services (ITMS) and deal with service operations used to bring a service to normal as soon as possible after a disruption.

Intelligent Transport System – ITS is an application of Information Technology (IT) which deals with the management of transportation systems, modes, and traffic to provide informed, coordinated, safer and efficient network to the user using smarter technologies.

Lay-out – The physical arrangement of characters (text) and symbols, on the display surface.

Legend – An authorized combination of words, numbers, letters, and symbols displayed on VMS to communicate information to road users.

Long-Term Signing – Any legend intended to be displayed for a period of two or more weeks.

Message – A configuration consisting of symbols and/or text.

Mobile VMS – These variable message signs are used at locations where service disruption has occurred but is temporary in nature. E.g., Leakage in water pipeline, work in progress, etc. These are low power consuming (battery or solar operated), easy to use and usable in varied situations and environments.

Paired VMS – Two consecutive VMS which either display the same legend, or two legends which contain related information. Each legend should make sense on its own.

Point-to-Multipoint (PMP) Communication – PMP communication refers to communication that is accomplished through a distinct and specific form of one-to-many connections, offering several paths from one single location to various locations. PMP communication is commonly used in telecommunications.

Point-to-Point Protocol (PPP) – In computer networking, It is a data link layer communication protocol between two routers directly without any host or any other networking in between. It can provide connection authentication, transmission encryption, and data compression.

Portable VMS – The VMS are placed on the verge, contain lesser units of information, and are used to fill gaps between the fixed VMS as per requirement.

Tactical VSS – Signs and signals which are located at a maximum of 5 km or 2 junctions from either the scene of an accident or incident (or other event which drivers need to be informed of), or from the rear of any queues which have formed due to an accident or an incident. When smart motorway signs and signals are used for managing non-accident or incident related traffic (e.g., the slowing of traffic at peak times, and/or the opening of a dynamically managed hard shoulder), there is no restriction on the distance they can be set over.

Traffic Management Services – These are the services or measures which are used to ensure the capacity of the road system, while improving the safety, security, and reliability of the traffic operations. It uses ITS systems and applications to deal with day-to-day operations.

Traveler Information Services – These are applications which provide information to the road users related to the incident location, weather and road condition, lane restrictions, road closure, alternate or optimal routes, etc. through collection and processing of information in real time.

Strategic VSS – Signs mainly located outside of the tactical VSS area, which warn drivers further away of the reason for any tactical VSS.

Variable Message Sign (VMS) – Asign for the purpose of displaying one out of number of messages that may be changed or switched ON or OFF as required.

3. SCOPE

The scope of the guidelines covers the following:

(i) The need, functional requirements, types, and purpose of installing the VMS. Alike road signs, the location to install the sign, and the aspect related to the visibility, legibility and credibility of VMS is presented.

(ii) The VMS information or messages will cover the user domains like 'Traveler Information Service', 'Incident Management Service', 'Emergency Management Service' and 'Traffic Management Service'.

(iii) The VMS Design Guidelines and Specification covering hardware like display, VMS enclosures, mountings, foundations, power management, controllers, and communication modules. It will also enlist the standard and specification compliances that need to be met.

(iv) The installation, testing and commissioning of the VMS including safety management, quality assurance and control, and system integration and testing.

(v) The operation of the VMS which includes specification related to VMS messages format, message content accuracy and authenticity, do's and don'ts related to message display, message configuration and management, and monitoring of system performance.

(vi) The information on maintenance of VMS, including preventive maintenance, incident maintenance, ensuring safety during maintenance and possible VMS failures.

(vii) Management of the TMC and response organizations, and requirements to be stipulated related to manufacturer, vendor, or installer.

(viii) Information on standard messages to be used under different domains, responsibilities of TMC manager and VMS operator, system architecture of emergency response system, and general specification related to VMS devices.

These guidelines are primarily targeted to the road and traffic engineers who are involved in the design, installation, operation, maintenance, and management of the road systems on a day-to-day basis. These guidelines shall be read in association with the Indian Roads Congress Guideline on Road Signs.

These guidelines shall not be treated as a stand-alone solution capable of meeting a specific requirement as mentioned under the functional and operational requirements related to VMS.

These guidelines are not intended for city administration and municipal authorities who may be more inclined towards use of VMS for general announcements or revenue generation through display of advertisements and for display of politically or religiously motivated messages.

However, as the guidelines speak of the operational and installation specification related to the VMS, these can be used for implementation with proper justification by other authorities until the usage does not hinder the primary purpose of the VMS as stipulated in these guidelines. The idea of these guidelines is to:

a) Make best and effective use of VMS infrastructure and technology

b) Maximize the benefits which can be derived from the investment in VMS technology so that the road network becomes more efficient

c) Create a harmonious environment for road users, society, and community, along with the authorities dealing with public aspects

4. ITS ARCHITECTURE

ITS architecture can be defined as a system architecture that is developed for operation of an Intelligent Transport System. From operation point, the ITS Architecture is a combination of four viewpoints that are listed here:

- Logical or functional viewpoint, which deals with the data flow and its processing
- Physical viewpoint, which deals with the physical components of the system
- Communication viewpoint, which defines the two-way communication between physical components or between physical component and external source of information
- Organizational viewpoint, which is important to define the roles and responsibilities of participating systems, communicators, information providers and recipients related to ITS services

ITS Architecture works at two-levels: High-level and Low-level architecture. High-level architecture basically defines the conceptual design that is needed to provide an ITS service. The specifications are technology independent, that means the selection of technology, components and communication are open thus giving a supplier freedom to select the most feasible technical solution that satisfies the overall architecture. The high-level architecture will include the above-

mentioned viewpoints along with a deployment plan, a cost-benefit analysis, and a risk analysis. The interrelationship between these is shown in **Fig. 1**.

On the other hand, the low-level architecture looks at the actual design of hardware, software, data exchange and communications. It includes specified technology and ITS standards to comply with. The High-level architecture relies heavily on research, standardization, and manufacturing capabilities, and therefore, may not be best suited to the present scenario. Low-level architecture may be adopted starting from the four services envisaged in the VMS. As regards standardization of the devices and the communication protocol, the existing international standards followed in the USA, European Union and Japan may be relied upon, provided interchangeability and interoperability of the devices over the systems is ensured.

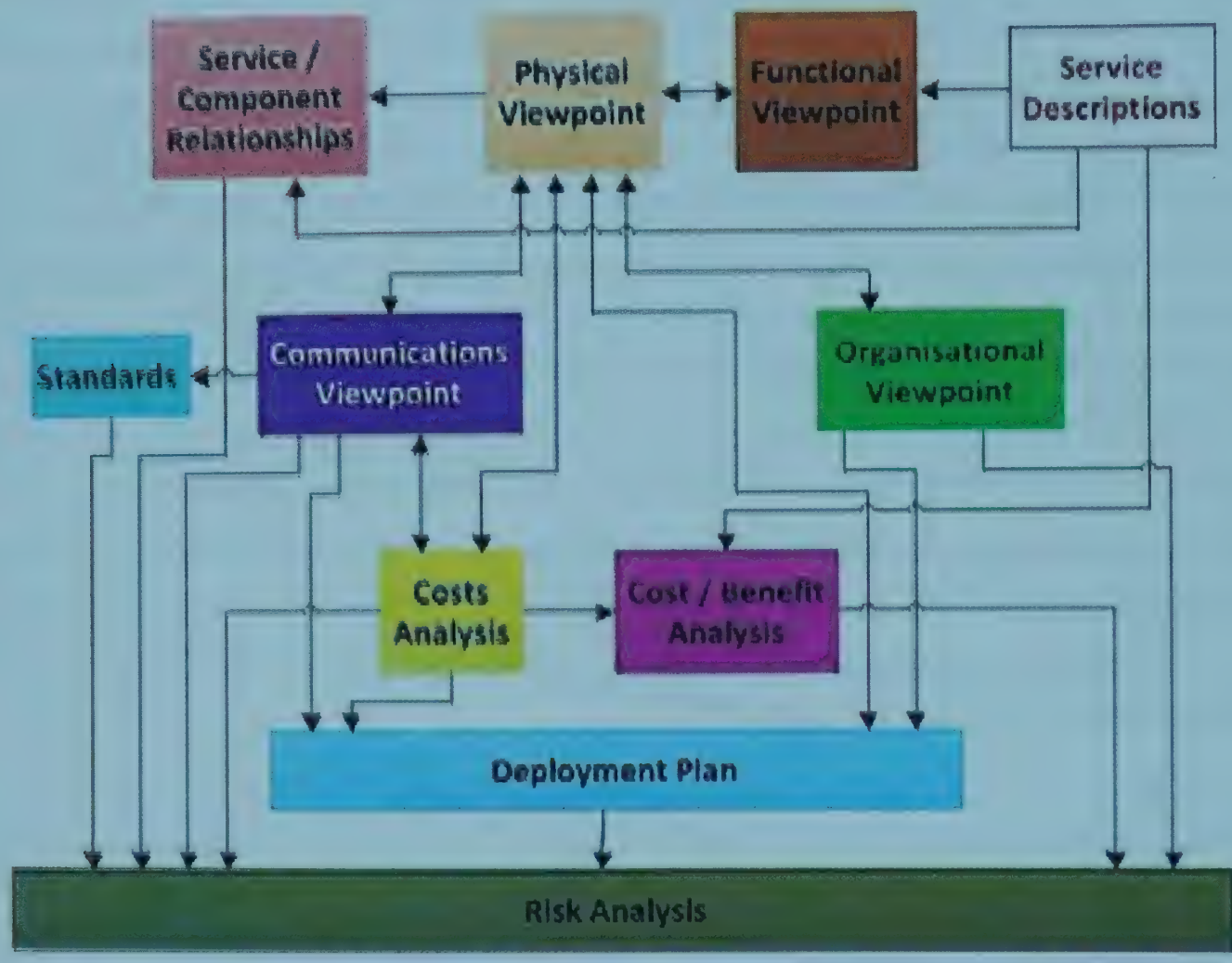


Fig. 1 Inter-relationships between Viewpoints and other aspect of ITS
(courtesy: mo-its.piarc.org)

High-level architecture works with two basic approaches - framework architecture and model architecture. Framework architecture is flexible in approach, allows refinement, development and extension or integration by the users, works with common norms, standards and practices, and suits where top-down approach is not workable. It also allows the creation of a stand-alone master plan for ITS at different levels. Model architecture works based on physical viewpoint and is usually developed while adapting to the needs and requirements of a region or an institution. It therefore considers system and sub-system components, their interrelationships, data communication requirements, etc. Adaptive architecture is an architecture developed for a specific ITS application using a framework or model ITS architecture template. It consists of the common set of functionalities and adds specific functionalities suiting to the requirements of specific services to be integrated. The decision regarding which ITS approach shall be used, is dependent upon the ITS system in place (or not) and the ultimate objectives of the responsible authority or the organization.

ITS Architecture should integrate various elements of transportation such as the travelers, roads, vehicles, and the agency which controls and manages the traffic. These should be interconnected, physically as well as in terms of the data flow. The physical 'interconnect' is through a communication layer (or communication network) while the data flow 'interconnect' concerns the way data are transmitted and received between the different elements through 'devices', and the communication layer. The TMC related ITS architecture may look like as shown in **Fig. 2**.

In this architecture, the traveler group consists of the travelers who are connected to the system either through information kiosk, Remote Traveler Support System, or computer or personal data access system. Centers denote the group of organizations who are involved in transportation management. Vehicle group indicates specific or generic type of vehicles which will require information for their use and safe movement. Field group connects infrastructure to the vehicles. It includes sensors installed along the infrastructure, Closed-Circuit Television Cameras (CCTVs), Dynamic Message Signs (DMS), tag readers (at toll plaza), violation detection and enforcement camera, weight-in-motion detectors, vehicle oversize detectors, etc.

The Centre shall collect information through field devices like sensors and the analyzed condition shall be displayed on VMS. The source of information can be road-side sensors, patrol personnel and the travelers on the road. The information will be transmitted to the TMC through a wireline or wireless communication medium, where these will be held in a road database (in GIS format) and the traffic database is stored on the TMC server. The processing algorithms for location reference and traffic analysis after coding will also be stored on the server. After processing the data, the TMC computer will select an appropriate message for display from a library of messages, which will also be pre-fed in the VMS controller's memory. The TMC computer will send a command to the VMS display to activate the selected message.

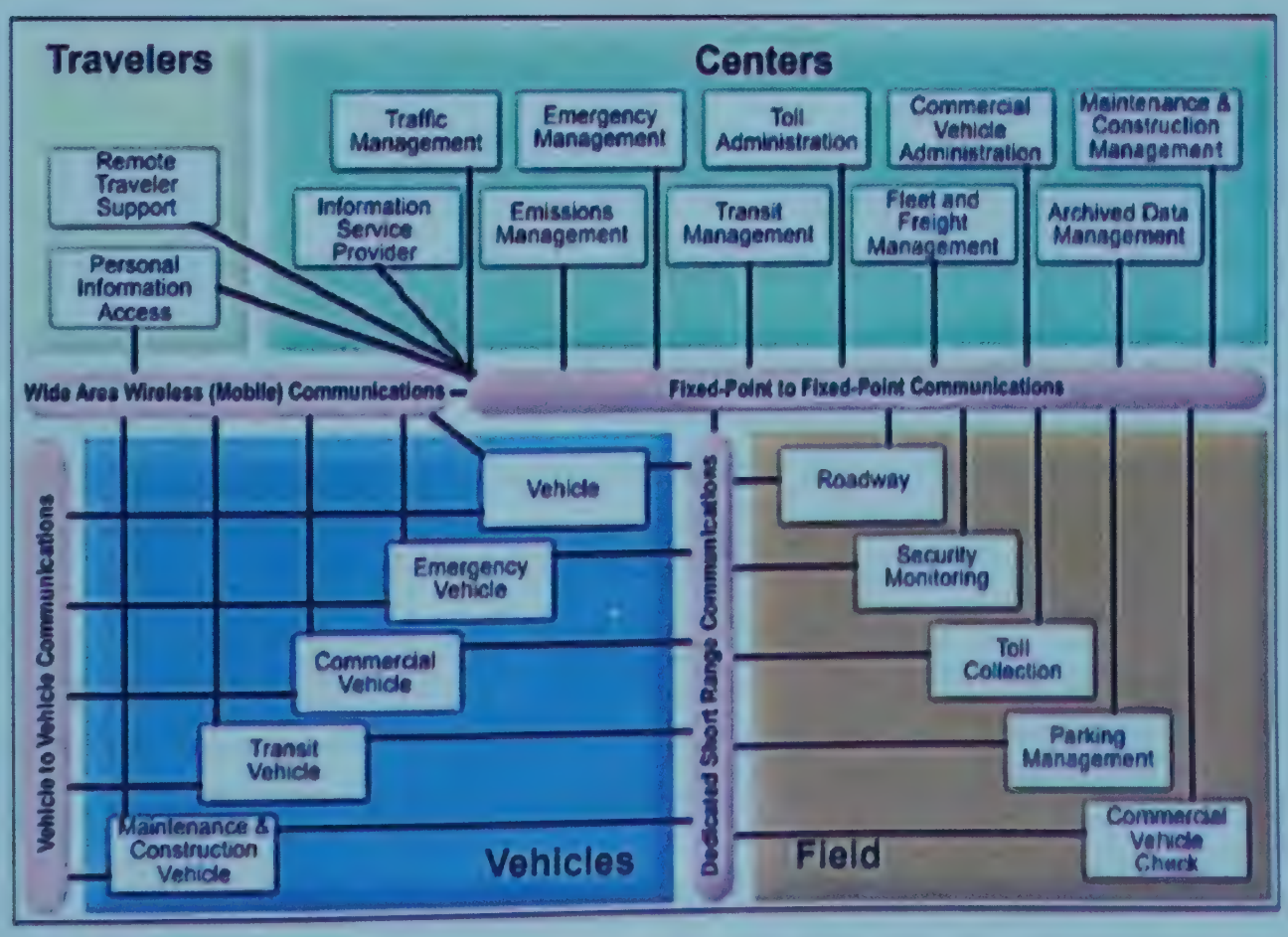


Fig. 2 Framework of ITS Architecture related to Traffic Management Center
(courtesy: https://www.codot.gov/library/studies/ports2plains)

The possible solution architecture and specific examples are given in **Annexure - A**.

5. VARIABLE MESSAGE SIGNS

Variable Message Signs (VMS) messages are used to inform and direct motorists of real time situations such as optimum routes, traffic congestion and emergency messages in a consistent and orderly manner. The messages are for the purpose of traffic control, management, and timely traveler information. VMS is a valuable and effective traffic control device. The objective is to give travel directions and enable the motorist to avoid an incident or prepare for an unavoidable condition well in-time. This will have a positive impact on the motorist's travel time and safety.

VMS can be continuous or discontinuous in nature. Continuous signs are like fixed signs, the difference being that they can show various messages by electromechanical means e.g., rotating prism signs, roller blinds, etc. Discontinuous signs create messages using individual elements that can be in one or two lines (or more) and can thereby create various messages on the same sign face. E.g., flip-disk signs, fiber optic signs, LED signs, etc. VMS used for dynamic traffic management are of the discontinuous type and make use of light emitting techniques (fiber optic or LED signs). The most suitable LED technologies for VMS are DIP (Dual-in-Line Package) and SMD (Surface Mounted Diode).

Generally, VMS systems form part of the Advanced Traffic Management System (ATMS), one of the major components of the Intelligent Transport System (ITS). The Integrated ATMS software receives online data from Automatic Traffic Counter and Classifier (ATCC), Meteorological Sensors, Traffic Control System, CCTV, Video Incident Detection System (VIDS), Emergency Call Boxes (ECB), etc. After processing and analyzing the data, information can be automatically shared with the road users through VMS, Internet, SMS, FM, radio etc.

However, Variable Message Sign systems can also be used independently for providing information to the road users effectively. In this case, the inputs to the VMS systems are pre-programmed messages stored in the local media player/storage device, real time data fed into cloud-based VMS software application, integrated command, and control center, and/or VMS mobile application.

5.1 Need of Variable Message Signs

Road signs, pavement markings and traffic signals are the mostly used control devices. These devices convey a fixed information at a location to the motorist. These devices do not ensure a disciplined driver behaviour. Lapse on part of the driver with respect to the static information being conveyed may result in a hazardous situation. E.g., A road sign can inform the driver of a horizontal curve ahead but cannot ensure that the driver approaches the curve at an appropriate speed to negotiate it safely. If a VMS is installed at that location, connected with speed sensors, then the driver can be informed to SLOW DOWN while approaching the curve. This will improve driving behaviour as well as safety. Similarly, in the event of an incident on the road ahead, VMS can inform the motorist of the incident and direct them to take an alternate route to exit from the highway system. Similar may be the case if the road experiences congestion which affects the travel time. In this case also the VMS can inform the motorist to take an alternate route to save on travel time.

The above-mentioned examples clearly define that though the existing control devices can convey the warning, cautionary, mandatory, prohibitory, and locational information to the motorists but any change in the traffic and road system which has occurred in real time cannot be conveyed by the fixed message control devices. In such conditions VMS have higher utility and can be used to ensure smooth and safe traffic flow on the road segment.

5.2 Functional Requirements

The VMS should meet the following requirements:

a) Fulfill a need

b) Command attention

c) Legible from a distance

d) Convey a clear and simple meaning

e) Command respect of road users

f) Give adequate time for proper response

g) Reliable and credible

h) Display contextual dynamic information

To minimize distraction and avoid overloading drivers with information through VMS, the following shall be adhered to:

- Try to limit the number of signs as much as possible.
- Do not give too much information on one sign.
- Try to use pictograms instead of words, if possible (also of importance for foreign drivers).
- Avoid acronyms
- Give information in a concise way; do not divert the driver's attention for too long.
- Try to employ uniform solutions to improve recognition.
- Repeat information, limited to two VMS per junction (information could be partially missed the first time and visual information is easily forgotten after a short time).
- Try to eliminate irrelevant information to reduce the amount of information drivers must assimilate.
- Avoid terms having multiple contextual meaning
- It should not repeat information already communicated / can be communicated through fixed signs.
- It should not display advertisements and public announcements.
- It should remove message immediately when the conditions cease to exist, or the restrictions are withdrawn
- Identical conditions shall be conveyed using same VMS message

5.3 Essential Features

VMS shall have the following features:

a) VMS solution should be capable of displaying real-time as well as static data.

b) VMS should be capable of storing messages and images.

c) Emergency message shall override a set of messages for a prescribed duration.

d) Diagnostics features shall be embedded in hardware as well as software to detect link or power failure, temperature overshoot, defect in display card, etc.

e) The system should be able to remotely detect errors in the cabinet like voltage status of SMPS (Switch Mode Power Supply) and connecting cable status. Error pop-up should be raised at the command center application.

f) The system should be capable of detecting the unauthorized access of the display door and shall send the alert to the central control center.

g) The system should be capable of handling all kinds of weather conditions and the light sensor should have the control circuit to increase the stability and photosensitivity.

h) If pictograms are requested at a project site, then they shall be of suitable size ensuring legibility from a distance as per IRC standards.

i) The software should be fully programmable with different presentation modes, font types and sizes, and facility to embed graphics, animations, and image format.

j) The VMS shall have features to display current time, temperature, countdown related to an event, etc.

k) It shall have flexibility to display or change a message instantly from a PC on site or a remote location via wireless link or through the internet or through a secure hardware lock to ensure that there is no breach of security.

l) Display unit shall have a heating control system, weatherproofing, brightness, and contrast level controls, etc.

5.4 Types of VMS

5.4.1 *Fixed Variable Message Signs*

Fixed VMS may be gantry mounted or shoulder mounted. Gantry-mounted fixed VMS are more clearly visible from each traffic lane. Additionally, traffic lights can also be installed above each lane and shoulders to indicate which lane is open for traffic and which ones are closed. The shoulder mounted signs will have comparatively less visibility, legibility, and message exposure from the farthest lane due to set-back.

5.4.2 *Portable Variable Message Signs*

Portable VMSs are located on a verge, and not above a carriageway. Due to this all legends shown on portable VMS shall not normally contain more than 4 units of information, as the verge location affects the reading and reaction time required related to the information displayed. Equipment shall be portable and can be installed on the vehicle (Crane/Trolley mount). The location of the equipment shall be strategically placed to:

a) Ensure maximum visibility for the road user from all the traffic lanes of the carriageway.

b) Allow the road user sufficient time to read and comprehend the message and react.

Portable VMS shall be installed only to fill in the gap between fixed VMS, or if there is a requirement to show a legend 24/7, but in line with IRC guidelines for traffic signs.

The exact location shall be adjusted for the maximum utility to the users based on the site conditions, however, only with the consent of the authority.

5.4.3 *Mobile Variable Message Signs*

These can be mounted at the back of the truck or a similar vehicle. These can be powered through solar energy or a battery. They shall be so placed that they are effective and give adequate time to the driver to read, understand and react to the message displayed. These are placed at locations of major incidents like crashes.

The VMS can also be divided into two categories based on policies: Tactile and Strategic.

Tactile VMS focuses on providing information which warns the drivers of a crash or an incident that is immediately ahead on lane or road, thus protecting both those present at the scene and queuing or approaching traffic towards the scene. These are usually managed by local authorities.

Strategic VMS typically warns the drivers of closures, delays, and diversions. These are placed at sufficient far distance and locations allowing the drivers to make an informed decision about their travel ahead.

5.5 Purpose of VMS

The purpose of the VMS is to inform and guide the travelers in near real time. The information should be on the dynamically varying conditions on the road, relating to its physical conditions (e.g., closures, diversions, on-going construction/maintenance activity), incidents on the road (e.g., flooding, breaches, crashes), traffic conditions (e.g., congestion, speed, delays) and weather conditions (e.g., heavy rains, fog). The location where a particular condition occurs is another piece of information, which the VMS shall display. Guidance must be in the form of appropriate action to be taken by the traveler (e.g., take exit, use diversion, slow down).

Generally, VMS can be used for the following purposes:

5.5.1 *Traffic Control*

VMS can be used for lane and/or speed control purposes, and in most cases positioned over the traffic lanes to inform regarding lane change/closure/lane merge; speed funneling, speed harmonization, etc.

5.5.1.1 Lane Closure

Any road crash, which may cause blockage of a traffic lane for a substantial period, shall be informed to the motorists. VMS placed near the crash location shall inform the motorists of either to continue moving or using side lanes. The one placed further away upstream shall suggest alternate routes. Similarly, it may be used in the tunnels and on toll plazas, where red 'X' defines a closed lane and green arrow defines an open lane.

5.5.1.2 Special Event Information

These messages display information about future events that may affect traffic flow and safety. The messages should be displayed within a week of the event. In urban areas these messages shall be used only on through routes and high-speed corridors. There may be times where static signs would be more appropriate to use.

5.5.1.3 Work Zone Related Disruptions

The VMS can be used to warn the motorists of ongoing or upcoming construction activities that will impact traffic flow. The message may include information on lane closure, lane shift, one-way movement, etc. This will supplement provisions laid in IRC:SP: 55.

5.5.1.4 Vehicle Actuated Speed Display (Driver Feedback System)

VMS can be used to display, in real time, the speed of the vehicle crossing a point. For this the VMS shall be connected to the speed sensors. This can also be used to control speeding motorists at a location or to penalize them for crossing the speed limit in a road section.

5.5.2 *Incident/Disaster Warning*

VMS can be used to warn the motorists regarding:

- Road crash ahead
- Flooding/waterlogging ahead
- Fog/snow ahead
- Cyclone/rain/heavy wind/storm ahead
- Falling rocks/mudslide/landslide ahead
- Bad road surface ahead
- Overtopping ahead

The message shall also inform regarding the possible alternate route if available and the time it may take to clear up the section for flow of traffic.

5.5.3 *Information Display*

Informative messages should be displayed on large text panels in two or three lines of text, sometimes accompanied by a pictogram. The picture/symbol will be more useful. For example, Incident/accident, congestion/queue, road closures, parking availability, etc. Link messages (in future) may be displayed for information to motorists.

5.5.3.1 Parking Availability Information

VMS can be used to display information about the nearby parking availability at the upcoming/ nearby highway nest and guide the motorists. This information will not only reduce traffic on roads but also reduce parking of vehicles in no parking zones. VMS should be placed at entry points and exit points of the parking areas.

5.5.3.2 Traffic Diversion

Traffic diversion due to closing of a road or a section because of weather conditions, flooding, roadwork, major road crash, movement of oversized vehicles or movement of very important persons can be informed through VMS.

5.5.3.3 Fare/Fee Display

VMS can be used to display fee or fare at parking locations, toll plaza, etc. respectively.

5.5.3.4 Traveler Information

Probable time to reach the destination, Climatic conditions, Emergency number, General cautionary information like flood, route detour due to strike/curfew, etc., can be displayed through VMS.

5.5.3.5 Public Service Announcements

Public Service Announcements (PSA) may be displayed through VMS for a limited or short period. Such use shall be cautious so that the primary purpose and long-term efficacy of VMS

is not degraded. PSA shall not be displayed in urban areas during the peak travel periods. Under no circumstances shall the VMS be used for advertising of any kind. The PSA shall not be displayed prior to the approval of the concerned authorities. The total duration of display should not exceed two hours per day on any single message board. The display times shall be staggered, so the message will not appear at the same time each day, and the staggered times shall not fall consecutively.

5.5.3.6 Vehicle Arrival-Departure Status Display

This information is important for users of public transit systems. The information regarding arrival or a departure of a vehicle at a stop or a terminal can be informed to the users at the platform or outside the station/stop.

5.5.3.7 Other Information

VMS may be used to convey following information in the urban areas:

a) Recurring congestion
b) Non-recurring congestion
c) Weather related problems
d) Congestion due to special events
e) Routes closed or open
f) Speed restrictions
g) Parking information
h) Road narrowing or widening
i) Any changing condition that needs to be informed to the motorists

5.5.4 *Incident/Emergency Management*

VMS can be strategically used to inform motorists of any regional, corridor or project-based incident so that possible traffic congestion can be mitigated, and motorists can be informed of using pre-identified traffic detour routes. E.g., natural disaster notification, evacuation route information, etc.

5.5.4.1 Green Channel for Ambulance

VMS can be used to inform the motorists to give a path to the ambulance which may be carrying a patient. This may help in speedier movement of a patient to a hospital.

5.5.4.2 Amber Alert

A safe lane passage to be marked for a specific movement.

Standard legends related to VMS messages are given in **Annexure-B**. The tentative design templates indicating various messages are given in **Annexure-C**.

5.6 Location and Placement of VMS

The location of the equipment shall be strategically decided to:

a) Ensure maximum visibility for the road user from all the traffic lanes of the carriageway.
b) Ensure that VMS is accessible to the maintenance vehicles, even if traffic queue is developed.

c) Allow the road user sufficient time to read and comprehend the message and react.

d) Avoid cutting off or obstruction of VMS from trees.

e) Avoid locations with horizontal curves and vertical curves.

f) Ensure proper dissemination of information related to roadside facilities and utilities.

g) Ensure safety of the workers at roadside or vehicle parked due to break down or vehicular or pedestrian crossing ahead.

5.6.1 *Warrant Conditions for Placing VMS*

Following shall be considered regarding placement of the VMS:

a) VMS shall be located at an average interval of 10 km in each direction (not necessarily on the same gantry) to guide and forewarn the users about the traffic and weather conditions on the Highway/Expressway

b) Permanent VMSs shall be placed in advance of interchanges/flyovers/underpasses with slip roads on Highway/Expressways, where drivers can have the opportunity to take some action in response to messages displayed on the VMS

c) Before Toll Plazas to inform lane closure/open and toll charges for different vehicles as well as intimation of the toll deducted

d) Before toll plaza where vehicles can be made to wait and released at intervals by alternate red and green signals as a main-line metering measure to deal with downstream congestion

e) Ahead of entry and exit of approach roads to airport terminals and railway junctions.

f) At or near construction work zones (portable VMS)

g) Before and/or in the vicinity of multi-level car parking

h) Off-shoulder as pole mounted, clear of the traffic, with lateral clearance as specified for fixed road signs

i) To ensure proper viewing of the VMS, message sites must be located on tangent roadway sections.

j) As an off-line VMS before the entry ramp to indicate congestion or to advise not to take entry ramp or to inform that the entry ramp is metered. In such cases VMS shall be accompanied with metering signals.

k) VMS can be installed in-between two consecutive ramps to give advance information on the conditions ahead

l) The minimum distance of VMS on an expressway should be 1.50 km prior to the decision point. The sign should be visible from 300 m.

m) VMS shall be placed 100-200 meters before tunnel roads (shall be placed at a distance greater than Stopping Sight Distance)

n) VMS shall be placed 50-100 meters before major traffic junctions/diversions. (Shall be placed at a distance greater than Stopping Sight Distance or a distance traveled in 8s on a major road leading to a priority intersection)

o) VMS shall be placed 1.5 km before the interchange exit/entry on an expressway and 1.0 km on a National Highway or any access-controlled road.

p) Ideal site locations along roadway segments for placement is sections with 1 percent grade or less. VMS should not be placed along grades exceeding 4 percent.

q) If two or more portable VMS are to be used in succession, then they should be separated by at least 300 m

r) If crash barriers are provided, then they should be placed behind the crash barrier

s) There should be clear distance between existing road sign and VMS. The minimum distance between road sign and VMS should be at least 250 m on an expressway and 150 m on a National Highway.

t) VMS panel should be turned slightly towards the driver's view, by around 5 to 10 degrees from perpendicular to the direction of movement

VMS should be installed ahead of an exit so that in case of emergencies, the vehicles can take easy exit. The distance between the sign and the exit should be such that the vehicles from the outermost lanes should be able to change lanes, weave, decelerate and take the exit lane. In case the exit is closed, and the advice is to take the next exit, the exit lane traffic must change lanes and weave through the main traffic lanes. Portable and mobile VMS should be installed on need basis bearing in mind that sufficient distance is available for vehicles to complete the advised maneuvers (e.g., lane change, deceleration, etc.)

In case of portable or mobile VMS, the following may be considered while locating the VMS:

a) Signs, poles, or other objects should not obstruct the VMS

b) These should be placed on a level surface

c) They should not be placed within an intersection or an interchange

d) Their placement should not interfere with the working of other traffic control devices

e) Their housing should not affect the traffic flow in any respect

A VMS should not compete with existing roadway signs.

In general, a VMS should be permanently installed at the following locations:

- Upstream from the major decision points (e.g., exit ramps, freeway-to-freeway interchanges, or intersection of major routes that will allow drivers to take an alternate route)
- Upstream of bottlenecks if any
- Where regional information concerning weather conditions such as fog, wind, or dust is essential

A DPR/feasibility consultant should specify the specific requirements in Schedule-C of contract documents.

5.7 Visibility and Legibility

Visibility and legibility of the messages are other important issues concerning VMS. The signs should be visible from a distance (visibility distance) thus alerting the driver to expect a message and look for it. Some further distance down, the driver shall be able to read the message (legibility distance). This distance shall be such that the driver is able to read the message at least twice and comprehend its importance. The VMS will disappear from the driver's view when the angle between the line of sight and the direction of travel exceeds 10 degrees (which usually is the

cone of vision). The visibility and legibility distances depend upon the geometry of the road, particularly the set back of the signs for which allowances must be made. These also depend upon the background lighting conditions (daytime, nighttime, backlight), weather conditions, the width of characters and the aspect ratio (height to width ratio).

5.8 Credibility

Credibility of the message is critical. Without credibility, even the best message will go unheeded. Credibility of the displayed messages on VMS is of utmost importance for its effectiveness and compliance. If the messages are not credible (e.g., they convey information which are inaccurate, irrelevant, outdated, or contrary to the actual ground situation in real time) the users would lose respect for such messages and pay no heed to them. Repetitive messages (repetition of the same message as displayed earlier or repeating a message that is already displayed on the fixed signs), campaign messages (e.g., social campaign, safety campaign, advertisements) and platitudes (e.g. lane driving is sane driving) should not be displayed on the VMS. The default mode of VMS should be 'off', which indicates the normal condition, and the traveler should follow the messages on the fixed signs. The VMS should be in active mode only when some message related to an event or incident which has occurred on the road is required to be conveyed.

VMS will lose credibility and will not be respected if any of the following happens:

- Information is inaccurate
- Information is not authentic
- Information is not current
- Information is irrelevant
- Information is obvious
- Information is trivial
- Information is erroneous
- Messages are poorly designed
- It does not dominate the surroundings to attract attention but is lost into it
- Information depicted as road sign is repeated on VMS
- Information is accompanied with some advertisement
- Information is not updated after the event

Thus, all the factors which are responsible for VMS credibility shall be taken into consideration while locating and designing a VMS.

To improve the credibility of VMS, the information shall be supervised. This practice will increase the likelihood of consistent messages among operators. Information Control Centers shall be responsible for authenticating the current information (content)/message at both national and regional level. Regional Control Center (RCC) or Regional Operations Center (ROC) shall authenticate and focus on providing accurate and current legends which warn drivers of an incident that is immediately ahead, thus protecting both, those who are present at the scene and others in approaching traffic. The National Traffic Information Centre (NTIC) typically warns of closures, delays, or diversions.

To ensure that motorists receive the most accurate, authentic, and relevant information at the right time, all other messages within the signing area must be removed by NTIC and RCC/ROC, when an incident, crash or delay occurs.

The purpose of VMS is to direct and guide motorists of real time variable information/message of incidents. So, it is very important that in case of no incident, the VMS signing area is prohibited from commercial advertisements of any product, service, campaign, event or political party's agenda and other such moving/static contents which are not related to variable incidents.

If the portable VMS is set up along the roadway and a message will not be needed for a period of next 4 hours or more, the sign panel should be turned away from traffic, parallel to the road's centerline. No blank signs should be facing the drivers for extended periods.

6. VMS DESIGN GUIDELINES AND SPECIFICATION

6.1 Choice of Display Size and Technology

VMS display has a matrix of dots or squares (pixels) arranged in three different manners: a character matrix, a line matrix and a full matrix. The pixels are illuminated in a pattern to display the individual characters (character matrix), different characters in a line (line matrix), or all the characters in any pattern (full matrix). Depending upon the technology, the pixels may be of different types: a disk having one reflective and one non-reflective face, which can be flipped by rotation (rotating flip disk technology), a Light Emitting Diode (LED technology), or a bundle of Optical Fiber strands (OF technology). In the rotating flip disk technology, illumination is achieved by flipping the reflective side on the front, in LED by applying a voltage that lights up only those diodes (or pixels) that require to be illuminated for forming the pattern, and in OF by lighting all the pixels by a light source from behind but closing those pixels not required to be illuminated by magnetic shutters so that only lighted pixels forming the pattern are visible. A full matrix LED display is the best option from a functional and economic point of view.

6.1.1 *LED Pixel Construction*

The VMS display board (DIP/SMD) shall use high intensity Light Emitting Diode (LED) to display alphanumeric messages. LEDs are grouped, mounted on a PCB to form a pixel. Each character is displayed by lighting up the relevant Pixels. Pixel pitch (center to center distance of 2 adjacent pixels) should be 4 mm to 10 mm depending on pixel size and character sizes. Cabinet Pixels should have a pixel density of 10000 dots per sqm to 62500 per sqm. Minimum Brightness of the LED should be 5500 cd per sqm with manual and automatic brightness control. The maximum power consumption of the VMS should be 400 W per sqm for DIP and 600 W per sqm for SMD or lower and the average power consumption should be 250 W per sqm for DIP and 350 W per sqm for SMD or lower.

6.1.2 *Display Properties*

The optical system shall provide a uniform display across the sign, so that there is no visible difference in luminous intensity from any one pixel to another pixel, under any brightness level. The luminance intensity (also called luminosity) shall be measured at the front of the sign in its final position with any component that could impede or otherwise affect the light output (such as the front face, mask, and polycarbonate) in place.

The luminance intensity shall be at least 5,000 cd/m^2 (EN12966). The luminance intensity shall be measured at the front of the sign in its final position with any component that could impede

or otherwise affect the light output (such as the front face, mask, and polycarbonate) in place. Luminance, Luminance Ratio, Color Class, and Beam width should adhere to the EN12966 standard on LED/VMS.

Table 1 Class Designation of the Photometric Parameters of the VMS (*Source: EN12966*)

Visual Performance Parameter	Class Designation	Remarks	Recommended for Highways
Color	C1, C2	C2 is more restrictive	Color Class C2
Luminance (L_a)	L1, L2, L3, L1 (*), L2 (*), L3 (*)	L3 has the highest luminance (*) for specific situations	Luminance Class L2
	L1 (T), L2 (T), L3 (T)	These classes are for tunnel use	These classed are for tunnel use
Luminance Ratio (LR)	R1, R2, R3	R3 has the highest luminance ratio	Luminance ratio R1
Beam width	B1, B2, B3, B4, B5, B6, B7	B7 has the widest beam	Beam Width – B5 or Above

Colour: A VMS may be able to display one or more of the colours red, orange, yellow, white, green and blue specified herein. Colour class shall be declared as C1 or C2 respectively. Colour class C1 would allow "pure red" (beyond 630 nm), which is hardly visible for colour blind people.

Luminance: Luminance depends on the used pixel-pitch (resolution of light dots), as well as the number of light sources of the same colour per element (light dot). L1 will not be visible properly in bright sunlight, L2 is recommended considering less power consumptions and visible in bright sunlight, L3 requires more power consumption.

Luminance Ratio: Luminance ratio is a balance between light-output and sign-reflection. Ideally the value of luminance ratio should be kept as low as possible. R1 is having lowest luminance Ratio.

Beam Width: Any luminance at all measured angles within the horizontal and vertical beam width shall not be lower than 50% or more than 150% of the measured luminance on the reference axis. Application of beam width class can be (for sign mounted at high level):

B1	High speed road with two running plus one safety lane
B2	High speed road with three running plus one safety lane
B3	High speed road with four running plus one safety lane
B4 to B6	Medium speed road
B7	Urban area, highways with extreme road curvature and special conditions requiring wide horizontal and vertical beam

6.1.3 *Luminous Intensity Uniformity*

The ratio between the brightest pixel and the less luminous pixel shall be less than 3:1 when measured at the front of the sign with all components in place. The board shall be designed for automatic adjustment of the display brightness (LED Intensity) to the ambient light based on Light Dependent Resistor (LDR).

6.1.4 *Display Change Time*

The display shall change from one page of text to another in less than 100 ms. Changes from one message to another shall take place so that the motorist visualizes only the complete and intended message on the sign face, at any one time. No other message interpretations other than the intended message shall be possible during transitions from one message to another. All lines of text shall energize and de-energize simultaneously.

6.1.5 *LED Light System*

All LEDs used in a sign shall come from the same LED component manufacturer and shall be non-tinted, non-diffused, high intensity. The minimum Life Span of the LED should be 1,00,000 Hours. The minimum operating temperature range of the LEDs shall be -10°C to +55°C.

6.1.6 *LED Color Options*

The colours shall be True Color or Full-color (combination of red, green, and blue LEDs) creating 16 million colors. The visibility of the colour shall be considered with respect to the background colour. These shall be Traffic Colours and the combination of background colour and message colour shall be as specified in IRC:67 for information sign, etc.

6.1.7 *Display Style*

It should allow different styles of display of information, say steady, flash, partial flash, right entry, left entry, top entry, bottom entry, canter spread, blank, and dimming.

6.1.8 *Display Requirements*

Usually, the display background shall be non-reflective. In most of the cases it shall be black in colour. However, colours like green, blue, yellow can be used for background with message displayed in white (on green and blue background) or black (on yellow background). There are 2 types of displays as follows:

a) Text only display – These shall be displayed in true color with contrasting combination, preferable Red/Amber Color. (Wavelength is more, thus scattering will be less for Red Color)

b) Combination display – These combine the text and graphics units into one unit.

6.1.9 *Language Requirements*

The VMS system must display messages in three languages i.e., English, Hindi, or Regional Language.

6.1.10 *Size of VMS*

The size of VMS is represented in length (l) x height (h) x depth (d) measured in meters. The three dimensions mentioned are end-to-end measurements which consist of the LED area and the structure frame hosting the LED cabinets. The LED area that is the actual area which can display content on the VMS is also called the Active Area. It is critical to consider that the VMS is mounted on a structure at a height of around 6 meters from the ground. As a result, the size of the VMS should be such that the messages are legible from a minimum distance of 300 m for expressway and 200 m for other roads. The minimum VMS dimensions for different roads are given in **Table 2**.

Table 2 Minimum VMS Dimensions

	Recommended VMS Dimensions	Active Area Dimensions	Recommended Application
Highway (NH and expressway)	9m x 2m	8.64m x 1.92m	Across the road on Gantry or FOB with more than 3 lanes on one side
	5m x 3m	4.8m x 2.88m	Ideally oriented in middle of the Center Island with more than 3 lanes on one side
	3m x 2m	2.88m x 1.92m	Aligned on the Shoulder of the road before junctions/interchanges etc.
Urban Roads	3m x 2m	2.88m x 1.92m	Aligned on the Shoulder of the road before junctions/interchanges for advance traffic information. May be fixed on Gantry or FOB
Tunnel Roads	2m x 1m	2.88m x 1.92m	At Entry of Tunnel
	1m x 1m	0.75m x 0.75m	Inside the tunnel; ideally one for each lane
Hill Roads	4m x 2m	3.84m x 1.92m	Aligned on the Shoulder of the road before junctions/interchanges etc.

6.2 Choice of Type of VMS

6.2.1 *Fixed Vs Portable*

Fixed VMS shall be provided at:

(i) major entries to Project Highway,

(ii) before major junctions on the main carriageway that can lead to alternate routes to the highway,

(iii) before each big village or town on Project Highway with potential of traffic congestion.

Minimum visible distance of VMS shall be 200 m. Message languages: Hindi, English and Local language.

Portable VMS shall be considered for the below applications:

(i) Temporary Work zone

(ii) Emergency message in case of Road Closure/Lane closure.

6.2.2 *Full Vs Part*

Full: New Projects, New Installations depending on type of road and application

Part: Hybrid Signs with Static facia and Dynamic message display using VMS Screens.

6.3 VMS Gantry/Mounting

Mounting Structure shall use minimum 6.5 m high MS pole/Galvanized Pole (with sufficient stiffeners). It shall be painted with one coat of primer and two coats of PU paint / Galvanization. The support structure for the VMS shall be of MS IS: 2062. MS unipole shall be minimum 300 mm diameter and 5 mm thick. The base plate shall be minimum 520 mm × 520 mm × 16 mm. The structure shall be supported on the ground through appropriate concrete foundation with M25 concrete mix. The minimum vertical clearance under the sign shall be 6.5 m to the road surface.

The mounting structure to be provided for the VMS units shall be sturdy, aesthetically designed, and capable of bearing wind loads at least up to 200 kmph.

It shall be provided with a walkway to allow at least 2 persons to carry out maintenance of the VMS without obstructing the carriageway. Safety barriers shall be provided at gantry support column (s) for their protection and for safety of road users. The concrete pedestal for the support column should be flushed with ground but in no case should protrude for more than 15 cm. Maintenance walkway shall be provided on the gantry at the rear of the sign- case.

All component parts shall be easily and readily accessible by a single person for inspection and maintenance. There shall be room for a technician to work. The VMS should have in-built lighting to assist maintenance work during low light conditions and night.

Several accesses are possible and should be defined on project basis. It is important to define the VMS access in accordance with the design of the supporting structure to ensure that the mounting arrangement is adequate and possible. Various Type Design are given in **Figs. 3, 4 and 5**.

6.3.1 *Walk-In Access*

The VMS enclosure provides a walk-in access. Walkways along the support structure shall be provided. Walk-in housings shall allow access to all components from within the sign. A non-skid floor shall be provided, so that a maintenance person can walk to either end of the interior with a minimum of 60 cm (24-inches) of aisle space to perform his duties.

6.3.1.1 Walk-In Access Door

The sign shall have one access door, which shall be rain, insect and dust-tight and shall open outward. A stop mechanism shall be provided to keep the door in the open (90°) position. When open, the door shall be sturdy enough to withstand wind gusts of 64 km/h and not be deformed. The door shall be equipped with a proper latching system. A door handle must be provided outside and inside the housing so that a person with no key or no tools cannot be trapped inside the housing. A door switch shall be provided and wired to the VMS controller so that the position of the door (open or closed) can be monitored. This information shall be transmitted to control center upon request.

6.3.1.2 Walk-In Work Area

The dimension of a non-obstructed interior walkway must be minimum 60 cm (24 inches) wide and 180 cm or 1.8 m high. The structural members shall not obstruct any movement of technicians inside the work area. The sign floor shall be designed to avoid water retention. A minimum of four drainage holes,designed to prevent the entry of insects and the accumulation of dirt and moisture, shall be provided.

6.3.1.3 Walk-In Light Service

A minimum of one 60 W fluorescent light for every 2.40 m of housing shall be provided. The light assembly shall be protected by a cage. A manual timer having a maximum ON time of two hours must control all lights and must be placed near the entry door so that the light will automatically be switched off. It shall be noted that no maintenance can be done without internal light system as it will be impossible to see the electronic equipment in dark.

Fig. 3 L-Type (Cantilever) Mounting Structure

Fig. 4 Simply Supported Overhead Gantry Structure

Fig. 5 Unipole T-type Mounting Structure

The design steps related to provision of VMS on overhead Gantry (cantilever and simply supported both) are given in **Appendix- D**.

Gantry structure shall be designed for:

a) Wind load induced due to wind speed of 200 km/h (as per clause 7 of IS 875 (Part 3))

b) Dead load of the structure

c) Live load due to working by maintenance and repair staff

6.3.2 *Canopy Doors*

The access doors shall be properly hinged so that when the access doors are in the open position, they shall create a temporary shelter that consists of a roof and partial rear wall. When all the doors are open, the canopy shall protect the electronic equipment and maintenance personnel. The doors shall be easily openable and the gap between two adjacent doors shall be adequately designed. Opening a canopy door shall allow maintenance personnel immediate access to circuit boards and internal sign parts, without having to remove any items in the sign, or the need to use any tools or to remove any device that could be dropped or lost, such as a locking pin or bolt. The manufacturer shall furnish any catwalks or framing members necessary to offset the back of the sign from the structure, to reach the sign from the roadside and to provide workspace and door clearances. The manufacturer must provide a solid floor (diamond etched catwalk) at locations with overactive traffic, to allow maintenance personnel to work over live traffic.

6.3.3 *Ventilation*

The system shall be designed to adequately cool the pixels from all sides along with the front and rear of the display module and all other internal components, as well as to have circulation of fresh air.

6.3.4 *Housing Specifications*

The housing shall be capable to withstand the following conditions for Vibration Test:

(i) Frequency range: 10 - 50 Hz

(ii) Vibration amplitude: 0.35 mm

(iii) Duration of endurance: 20 sweeps cycle

(iv) Duration at resonant frequency: 30 min + 1 min

6.4 Civil Foundations

The foundation of the gantry-based structures shall be designed by a structural engineer for the prevailing soil, material, and meteorological conditions. The concrete pedestal for support column shall be flushed with the ground but in no case shall be protruding for more than 150 mm above the ground. Foundation shall be designed considering seismic load as per clause 6 of IS 1893 (Part 1).

6.5 Power Management Unit

Power management unit includes various electrical equipment's and essentially provide electrical power supply for operation of Variable Messaging Sign. **Fig. 6** shows electrical wiring circuit for a typical VMS.

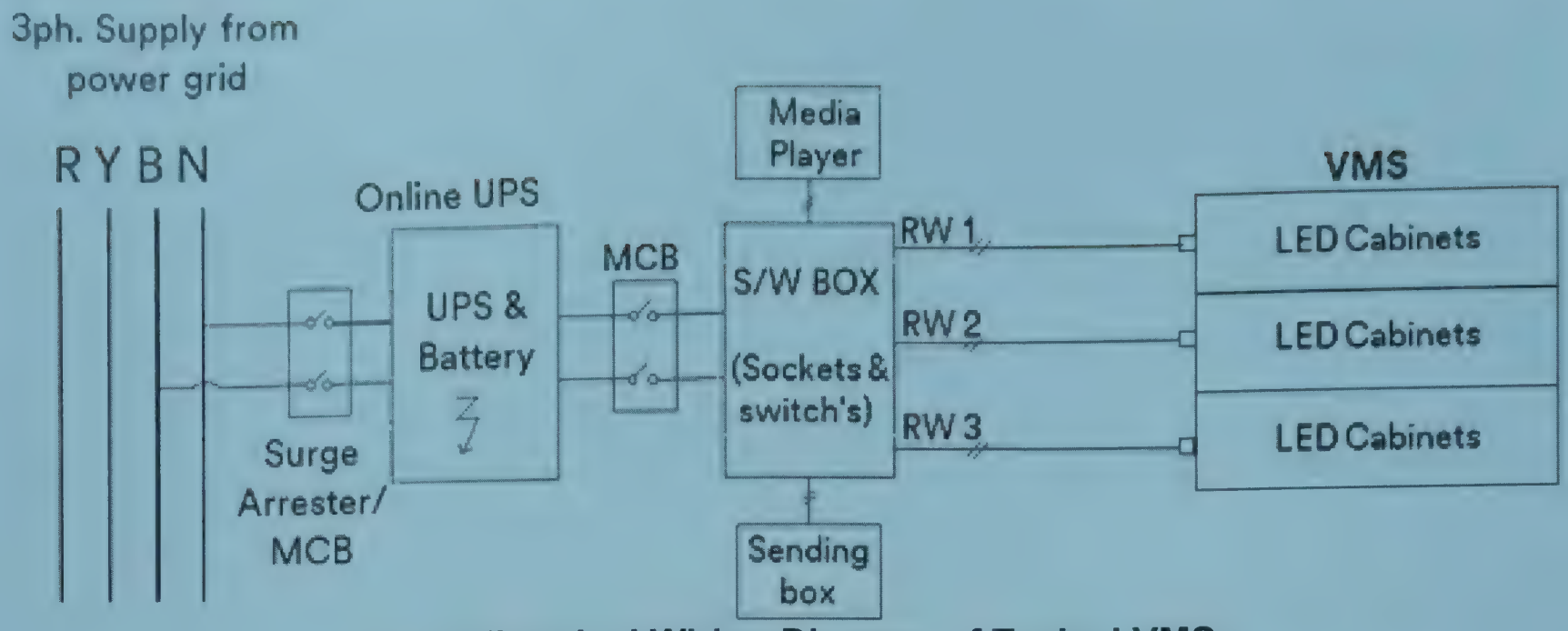


Fig. 6 Electrical Wiring Diagram of Typical VMS

Specifications of devices shall be as per VMS size and power requirement. Indicative values are given below:

- 3 Phase supply power grid – To get required power for operation of VMS.
- Surge Arrester/MCB – To protect UPS and other devices from high voltage and power fluctuations.
- UPS and Batteries – To provide uninterrupted stable power supply for operation of VMS.
- MCB – To provide protection against voltage/current fluctuations.
- Socket and switch box – To provide multiple power outputs for functioning of VMS Cabinets, Media player, sending box etc.
- Media Player – Act as CPU of the VMS and operates on 1 Phase supply.
- Sending Box – Act as a Modular and operates on 1 Phase Supply.

Power requirement for different sizes of VMS is given in the **Table 3**.

Table 3 LED Power Consumption Chart

VMS Size in meter	No of Cabinets	Min Power (Watts)	Min. KVA	Max Power (Watts)	Max. KVA
5x3	15	200	3.31776	400	6.63552
3x2	6	200	1.327104	400	2.654208
2x1	2	200	0.442368	400	0.884736
4x2	8	200	1.769472	400	3.538944

Wherever feasible and appropriate, the solar power shall be used for supplying electricity to the VMS installation.

6.6 VMS Controller

The VMS Controller provided at the location is connected to the display unit. It shall be a microprocessor-based VMS Controller (CPU) capable of auto reboot system in case system error pop ups. The cabinet housing the controller shall have -

- Main power supply and energy distribution system
- One work lamp to illuminate the work area, when the cabinet door opens
- Lightning protection and terminations for the communication and control cables
- Termination blocks for the control cables to and from the VMS sign housing

In case of internet outage, the processor should be able to discard live content slides and play only static slides. Once the internet is established, VMS should automatically play both live and static content without any manual intervention.

VMS processors should be able to showcase data in static as well as dynamic animations based on the weather conditions in real time for weather content slides.

6.6.1 *Controller Functions*

The VMS Controller shall continuously monitor the display of the sign, independent of any external commands, and shall cause the signs to display all the appropriate characters. The VMS Controller shall command the sign to display characters and messages by turning the LEDs ON and OFF. In addition, it shall accumulate data about the status of the sign (to be transmitted upon request) and shall receive commands from the hosted application on the Central Computer and Portable Maintenance Computer. The System should detect the failure of LEDs and should send the alert to the central control center along with LED Parameter Diagnostics.

The intensity of VMS shall have six levels and it shall select the correct level automatically depending upon the ambient light conditions. For this, VMS shall have photo sensor and dimmer control.

6.6.2 *Controller Electronics*

VMS Manager Application is hosted on clients Virtual Machine. The Virtual Machine can be a Windows based Server (2012, 2016, 2019) with Static IP. In case of a client not able to provide Virtual machines, a Work Station with the latest operating system (RAM and storage) should be used to host the VMS Manager Application.

The Operating System and on-site processor should be able to support the VMS Manager Application to manage a minimum 500 VMS clients.

6.7 Communications Module

Each VMS Controller shall be uniquely addressable from the Control Center via the communication system for control and monitoring. The communication profiles that must be supported by the controller are:

PMPP (Point to Multi Point Protocol) - NULL, PPP - NULL, Ethernet - UDP/IP, RS-232, RJ45, Wi-Fi, Sim Based Router.

The VMS Controller shall be capable of communicating using NTCIP or other equivalent international protocols. Each VMS unit shall be provided with a unique Identification Number and shall communicate with designated Central Control Computer only. Sufficient security checks shall be implemented before accepting messages for storage or display. VMS unit shall respond to command, generated by Central Control Computer, for Communication link diagnostics. The VMS unit shall be able to accept messages created on the Central Control Center, using Graphical User Interface application. Messages shall be accepted either for storage or display. It shall display various message attributes like message blink, message blank, and message entry

styles (Left, Top Bottom entry). The VMS unit shall be able to send its health status to the Central Control Center on query basis. This query shall be generated by the Central Control Computer and transmitted to the VMS unit. Health status info shall include individual display matrix LED status, Controller status, etc. All this information shall be Time and Date stamped for proper MIS report generation.

6.7.1 *Recommended Power and Network Connectivity and Bandwidth*

Network connectivity and Bandwidth Requirement:

- Minimum 2 Mbps speed required to upload and download content.
- Sim based router or Wired Network

6.8 Software Requirements

VMS Software application should get integrated with futuristic Integrated Command and Control Center platforms, ITMS software platforms and open-source mobile applications. It should automatically collect data from various smart sensors and use the real time data for situation analysis. Data collected should be easily usable and should pave the way for future predictive analytics which will solve real world problems of traffic and congestion on roads. The solution proposed shall have the facility to generate Real Time Information of Traffic Data i.e., Traffic Live Congestion, Journey Time, Traffic Rerouting, Live Weather, CCTV feed and other updates as required based on usage application and type of roads. Capability of having split screens with Live and Static data displayed simultaneously can help to display two information's together in one screen.

VMS Application shall support "https" and "sFTP" (FTP Secure) for secure data transfer and shall have 128-bit Encryption of Playlist stored locally. Intelligent software encryption and hardware lock to secure and restrict unauthorized access to hardware and application on site location shall be ensured.

6.9 Standards and Specification Compliance and Hardware Life

a) Temperature shall be monitored inside the board and temperature information shall be communicated to associated software when asked for.

b) Serial ports should be provided for connection to the control room or local laptop.

c) Cabinet design shall be modular for easy replacement without need of any soldering.

d) The hardware memory shall be such as to store at least 24 message signs as per IRC standards.

7. VMS INSTALLATION, TESTING AND COMMISSIONING

7.1 Pre-installation Guidelines

7.1.1 *Approvals*

All structural design, checking, certification, testing, and installation work associated with the supply of VMS supporting structures, VMS enclosures and VMS walkway housings and access arrangements shall be reviewed and ensured compliance to respective standards and specifications. Especially utilization of any existing services or structures for any purpose that requires approval from other local authorities shall be taken.

7.1.2 *Installation Methodology*

Based on the type of VMS and it's mounting structure a detailed installation methodology must be prepared taking into consideration the instructions provided in respective OEM installation manuals. The methodology shall be discussed with all the key stakeholders, finalized, and approved from competent authority.

7.1.3 *Installation Plan*

Site Inspection shall be conducted especially in case of fixed large cantilever/gantries for assessing maneuverability of installation crane, availability of electrical power, safety, and traffic diversion/management needs. Site-specific installation plan and schedule including resource requirements shall be prepared and notified to all concerned. Installation schedule shall consider prevailing weather conditions (to avoid extreme weather), traffic conditions preferably lean periods to avoid any traffic congestion.

7.1.4 *Material Delivery and Inspection*

All the material (type and quantity) required for installation, testing and commissioning of the VMS shall be checked for its availability and compliance. Any deviations/errors/damage shall be reported, and installation shall not be taken up without rectification and re-certification of the same.

7.1.5 *Staff Deployment*

Only trained and authorized team for respective technical activities and safety shall be deployed for installation, testing, and commissioning activities.

7.1.6 *Coordination Meetings*

Prior to the VMS installation especially large gantry-based units, meetings should be held with all the key stakeholders to coordinate the safety and traffic management measures.

7.2 Installation

Installation of VMS shall be undertaken strictly in adherence to the approved plan including the sequence and methodology. Proper testing and certification of installation of the respective component shall be ensured before moving to the subsequent stage of installation.

7.2.1 *Civil Foundations*

a) Size and specification of the foundations for VMS and its road-side cabinets shall vary with the type and size of VMS.

b) Prior to the commencement of any work, the contractor must verify the exact location of existing services and structures likely to be utilized, modified or in any way affected by the proposed installation. Excavation nearby other services must be undertaken in a manner that minimizes the risk of damage, e.g. hand digging or vacuum excavation. Damage caused by the activities of the contractor must be rectified by the contractor.

c) All earth works including trenching and backfill must be undertaken in accordance with specification. When an excavation is necessary for the installation of cable pits and conduits, the trench must be backfilled with full surface remediation. The backfill must be compacted

to match the surrounding soil density and graded to match surrounding surface level. No open trenches must be left unattended or accessible by the public at any time.

d) Care shall be taken to ensure foundations are set to the proper elevation and anchor rods are set in the correct pattern and orientation, are of the correct size, and are plumb with the specified extension and thread length above the top of concrete. No erection shall be taken-up till concrete reaches its design strength and proper curing shall be ensured. Proper care shall be taken to ensure all conduits for cables are installed as per the design and drawings provided.

7.2.2 *Erecting Supporting Structure*

Prior to start of the supporting structure erection, following shall be considered:

a) The work inspection of the foundation shall be done for any damage to the foundation or the anchor bolts/rods.

b) All traffic control and other safety measures as required as per approved plan must be in place and reviewed for compliance. Erection generally requires lane closures, and at times involve short-term total road closures. In areas of high traffic, erection may have to be performed at night, requiring temporary lighting for both a safe and complete installation.

c) Signs and other attachments shall be attached to the cantilever arm or sign bridge on the ground before erection. Even very large heavy variable message sign boxes should be attached to their supporting members on the ground, and this can be done off the site. If the attachments are not attached to a cantilever structure when it is erected, they should be attached immediately after erection. This is because the bare mast arms with no attachments are vulnerable to vortex shedding, which can quickly become destructive.

Following procedure shall be adopted for erection of support structure:

(i) Leveling nuts shall be placed and leveled. Typically, the bottom of the leveling nuts is set approximately 6 mm (0.25 inches) above the top of the concrete.

(ii) Posts or end frames are then erected on the anchor rods. Care shall be taken to avoid damage to the threads on the anchor rods.

(iii) Bring-up the leveling nuts on the low sides to level the base plate. The bottom of the leveling nuts must not be more than one anchor rod diameter above the top of the concrete. Now, the anchor rod nuts should be tightened.

(iv) The post or end frame shall now be released from the crane.

(v) Retightening the anchor rods for light poles to complete the erection is now complete, except for the post-erection retightening of the anchor rods.

(vi) In case of cantilever sign support structures, the mast arm or truss can now be installed. It is balanced on the crane and is brought up to position and bolted to the post.

(vii) For sign bridges, the sections (if there are more than one) are normally connected to one another on the ground and set in one lift. Lifting points must be located so that the bridge is

not overstressed during lifting. With the bridge set on the end supports, alignment should be verified, and connections brought up to final tightness.

(viii) Overhead roadway clearance should be checked.

7.2.3 *Roadside Cabinets*

a) Installation locations of the cabinets shall be according to the scheme drawings. The ITS Cabinet must be located within 15 m of the VMS sign structure, downstream from the VMS, to provide view of the sign for maintenance personnel, where practicable.

b) The cabinet shall be orientated so that the personnel working on the front of the cabinet are able to see oncoming traffic. Cabinets shall be mounted on an existing concrete plinth located beyond the hard shoulder and located so that both the front and rear doors can be accessed from the hard shoulder and opened without obstruction. The cabinet nameplate with the cabinet number engraved on it shall be near the top of the cabinet facing the motorway approaching traffic.

c) Cabinet shall be mounted properly and fastened to the base plate grouted in concrete thoroughly with the nuts and bolts ensuring level. It shall be ensured that all conduit openings in the foundation are properly matched and connected to the base of the cabinet.

7.2.4 *Electrical System*

a) Wherever practicable, the VMS cabinet must be powered by a metered electrical main supply directly from a local Electricity Board. In the event a connection to a local Electricity Board switchboard is not practicable, a meter may be installed in the Cabinet in accordance with applicable standards.

b) Roadside cabinet and display unit shall be pre-assembled, tested and certified for installation and termination of all the electrical components including the Power Management Unit (PMU), batteries, surge protection, lightning arrestor, MCB, switches etc.,

c) Earth pit shall be installed in compliance with approved design specification standards.

7.2.5 *Wiring and Terminations*

a) Ferruling shall be done as per industry standard on all wire terminations, in accordance with the electrical schematic and termination and interconnection diagrams. Ferrule numbers must be placed near the termination on either end of the wire. The wire number must be legible and placed in a location where it can be read without disturbing other wires.

b) Low voltage terminal blocks must be segregated from extra-low voltage and control circuits and be uniquely labeled. Where wiring bridges to a hinged panel or door, the arrangement must be such that the opening of the hinged panel will cause the wiring loom to twist longitudinally and not bend or rub on a panel edge or face. At no point must any undue stress be placed upon the wires. Stick-on type wiring harness anchors will not be accepted.

c) There must be no jointing or teeing of wires between terminals. Only one conductor must terminate on any one side of a terminal. Terminal link bars must be used should there be a requirement for more than two wires to be electrically connected at any one point.

d) An allowance must be made on the length of wire at each terminal to permit cutting and remaking of the wire termination at least once without interference with the main run of the wire.

e) All wire insulation must be non-hygroscopic, incapable of supporting combustion and suitable for the site-specific climatic conditions

7.2.6 *Labeling*

All equipment and devices must be identified with labels. Titles must be as specified on equipment electrical schematics and termination and interconnection diagrams. Labels must be black letters on white background and fixed by stainless steel screws only in slotted holes. Labels must be located so that they are not obscured by wiring or equipment and are visible from the normal access point. Labels must not be fixed to removable equipment such as duct covers and switchgear. Where access may be gained to live equipment with a voltage of 110 V AC or above, red labels with white lettering engraved 'DANGER' "###" (Voltage Present), must be installed. Letter sizes must be as follows:

- Main designation label 25 mm
- Danger labels 12 mm
- Instrument/equipment label 6 mm

7.3 Testing and Commissioning

Overall testing strategy/plan shall be developed to assess the compliance of the VMS system to different functional, physical, technical and performance requirements specified. Testing plan shall include different types of tests to be conducted during different stages of deployment of the VMS based on which the acceptance or acceptance with conditions for compliance at subsequent stages or rejection of the system can be decided. **Fig. 7** shows the systems which require testing.

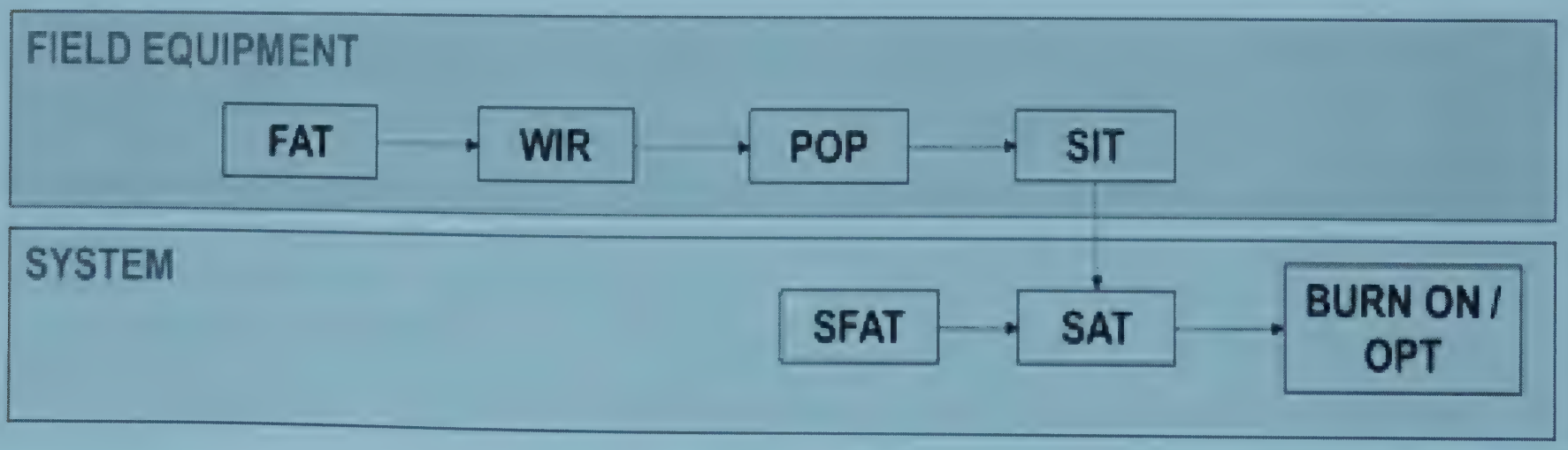


Fig. 7 Field Equipment and Systems which needs to be Tested

Some of the tests which are required to be conducted in a controlled environment and those which are done to testify the design compliance to standards need not be done separately and test certificates issued by authorized certifying agencies are acceptable. Type of tests, their purpose and stage of the deploying during which it should be conducted are summarized in **Table 4**.

Table 4 Type of Tests, Purposes, and Stages

Type of Test	Purpose	Period of Test
Factory Acceptance Test (FAT)	Ensures that the device meets the required functions	Prior to equipment being shipped
Work Inspection Report (WIP)	Ensures that the Physical Installation is done as per the design (Civil, Mechanical, Electrical and Electronic Components)	After completion of Site Installation.
Proof of Performance Test (POP)	Confirms that all equipment serves the required functions after installation	After Installation of Equipment and powering of the devices.
Sub-System Integration Test (SIT)	Confirms that each VMS device subsystem works properly as an integrated package.	After installation of field and Connecting the device to Control Center and after POP test
Software Factory Acceptance Test (SFAT)	Tests the functions of the software against the requirements.	After software has been developed/ configured
System Acceptance Test (SAT)	Tests the functions of the software against the requirements and demonstrates communication to each device (end-to- end test)	After the SIT for the location and the POP for all location devices is completed.
Operations Performance Test (OPT)	To ensure that the system is in a stable operating state,tracks system faults as minor, major or critical. Critical failures result in a restart of the test. Minor and major faults are resolved as quickly as possible.	After SAT and conducted for a period of 30 days of continuous operation.

For all tests, detailed test plans shall be developed with test cases clearly stating the purpose, requirement to be tested including reference to provisions of specific document which stipulates the requirement, process, tools/test environment required if any and expected outcome shall be prepared. OEM's documents and manuals shall be referred to in developing the test cases. Typical formats for each of the above tests are given in **Annexure-E**.

7.4 Safety Management

7.4.1 *System Requirements*

Safety requirements shall be ascertained for various stages of VMS deployment from designs (civil, mechanical, electrical, electronics and communications) location finalization, site installation and during operation and maintenance phases and safety management tasks shall be planned and undertaken. Compliance to relevant safety standards shall be ensured during each of the phases of deployment.

7.4.2 *Traffic Management Plan*

Site specific traffic management plans shall be prepared in consultation with all key stakeholders for installation and compliance to the same must be ensured.

7.4.3 *Coordination Meetings*

Regular coordination and training meetings shall be conducted with all key stakeholders for communicating the safety guidelines and traffic management plans and ensure compliance to the same during implementation

7.4.4 *Traffic Management during Installation*

Safety team shall be deployed to monitor the implementation and compliance to safety management plans. Any incidents shall be reported and analyzed for the root cause and feedback (if any) shall be incorporated in the traffic/safety management plans for all subsequent works.

7.5 Quality Assurance and Control

7.5.1 *Elaborate Quality Assurance Plan (QAP)*

Elaborate Quality Assurance Plan (QAP) shall be developed considering every component of the VMS sub-system and activities involved in every phase of deployment of VMS. The plan should elaborate on the tasks to be performed and mitigation steps to be taken in case of critical and non-critical deviations. The plan should address consistency in the inspection process and repair recommendations. The plan should address personnel qualifications essential to conduct the quality audits. Typical QAP for VMS is provided in **Annexure-F**.

7.5.2 *Quality Review and Meetings*

Regular quality review and coordination meetings shall be conducted to share the updates and educate the team on the deviations and potential impacts of the same on the time and cost of the projects.

7.6 As-Built Drawings

As built documentation i.e., built drawings shall be supplied by VMS implementation contractors for each of the locations and shall include:

- Site layout
- Support structures
- Installation elevations/plans
- Cabinet drawings
- Power supply arrangements
- Electrical compliance certificates

7.7 Design and Implementation Procedure for VMS

The design and implementation procedure for VMS is presented in steps. These are:

a) Collect preliminary data required for the proposed variable message sign deployment like

- Intended purpose of the VMS
- Type of information to be displayed on VMS
- Alternative route diversion points

b) Determine VMS type based on:

- Intended purpose of the VMS
- Type of information to be displayed on VMS
- Type of VMS technology

c) Determine corridor placement for VMS implementation considering:

- Alternative Route Diversion
- Existing Horizontal Alignment Data
- Existing Vertical Alignment Data
- Existing Sign and Traffic Control Inventory
- Location of source of power along roadway segment

d) Collect site-specific data required for the proposed variable message sign location considering:

- Base mapping with local roadway network linked to the segment under review for the VMS
- Existing roadway horizontal alignment
- Roadway vertical alignment
- Existing sign inventory
- Location of source of power along roadway segment

e) Select the VMS site while considering:

- VMS supports/location
- VMS height requirements
- Cabinet location
- Underground Infrastructure
- Power requirements
- Conduit routing
- Safety consideration

f) Determine cabinet placement for the VMS

g) Perform underground infrastructure

h) Determine the communications medium used for the proposed location

i) Revisit steps (d) through (h) until final design is complete

8. VMS OPERATION

8.1 VMS Messages

The messages should be as brief as possible but comprehensible at the same time because a traveler traveling at high speed has very little time to read and understand a long message before it disappears from her view. The information should be in 'units', each unit displaying one complete set of information. Experience suggests that a unit of information should not be longer than 18-20 characters including the gaps between the characters. Each display should normally contain 3 units of information and exceptionally 4 units. The most prevalent practice is to display one unit of information in one line: the top line indicating the 'information', the middle line the 'location' and the third line the 'action'. The brevity of the messages underlines the need for using common abbreviations. Where the requirement is to display multilingual messages, as in India, each language message should be displayed on a separate display panel.

8.1.1 *Message Content*

Variable Message Signs do provide a versatile means of communication for attending to a variable situation. The message, however, must be concise and clear for the drivers to interpret at high speeds while they can have any number of distractions. Each VMS board must be capable of displaying alphanumeric characters in English, Hindi, or local language. Pictorial signs already available for regular traffic signs can be useful as VMS.

8.1.2 *Timing*

The reading time is the time which a driver takes to read a message. The exposure time is the length of time a driver is within the legible distance of the message. The exposure time must always be equal to or greater than the reading time. Depending upon the speed of the drivers, the message length must be adjusted to ensure that the reading time fits into the exposure time.

Exposure Time >= Reading Time

Minimum legibility distance for portable VMS shall be 300 m for expressway and 200 m for other roads. **Table 5** gives the time in seconds it takes to travel 200 m and 300 m at various speeds.

Table 5 Time to Travel 200 m and 300 m Distance at different Speeds

Speed (km/h)	Time (seconds) for 300 m distance	Time (seconds) for 200 m distance
20	54	36
30	36	24
40	27	18
50	21.6	14.4
70	15.4	10.3
90	12.0	8.0
100	10.8	7.2
120	9.0	6.0
150	7.2	4.8

It is, however, recommended that the size and distance for clear legibility should be designed for at least 15 seconds for NH and 20 seconds for access-controlled expressways. Furthermore, the messages need to be displayed alternately in HINDI (or Local Language) and 'ENGLISH' and if possible, pictorially as well. The board having the facility to display a minimum of 2 lines of 12 or 15 English characters, can have English displayed in 1st line and other language in 2nd line. When the VMS displays a series of messages, 2 to 4 seconds per message is recommended for display. The blinking feature may be used on one or more of the messages. It should, however, not be used for more than one line of each message. Accordingly, reading distance shall be between 25 m and 115 m depending upon the speed (equal to distance travelled in 4s time, which can be taken as readability time for a 2-line message, and speed varying from 20 km/h to 100 km/h).The viewing distance shall vary between 25 m and 300 m depending upon the speed. If only one message is used, the sign may be at steady burn and the blinking feature may also be used for a single message. For example, the single message may also be ON for 2 seconds and OFF for 1 second.

8.1.3 *Height of Lettering*

Height of lettering shall be decided based on the VMS panel size. These will define the number of lines and number of characters per line which can be accommodated. **Table 6** gives the number of characters per line and number of lines for a given size of VMS panel. **Fig. 8** shows the effect of panel size on display of message with the change in size of the characters.

Table 6 Message Display for VMS Panel Sizes 1x1, 2x1, 3x1, 3x2, and 5x3

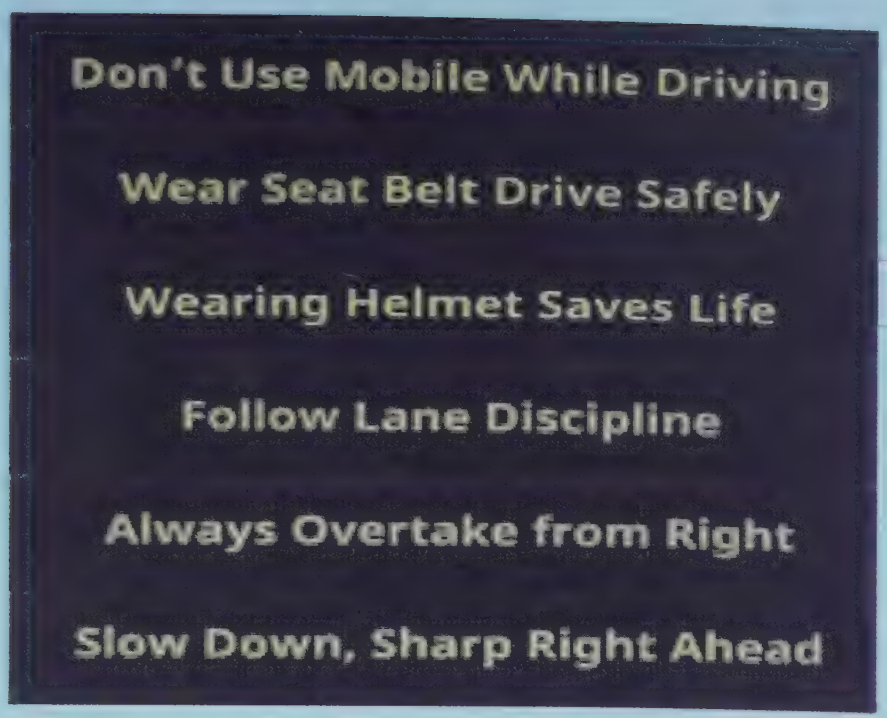
SMD - P 8 - 1 X 1		
Font Height	**No of Characters Per Line**	**No of Lines**
88 mm	14	6
100 mm	13	5
120 mm	12	5
135 mm	8	4
160 mm	7	3
182 mm	5	3

SMD - P 8 - 2 X 1		
Font Height	**No of Characters Per Line**	**No of Lines**
88 mm	28	6
100 mm	23	5
120 mm	21	4
135 mm	17	4
160 mm	15	3
182 mm	13	3

SMD - P 8 - 3 X 1		
Font Height	**No of Characters Per Line**	**No of Lines**
88 mm	42	6
100 mm	39	5
120 mm	36	5
135 mm	24	4
160 mm	21	3
182 mm	20	3

SMD - P 8 - 3 X 2		
Font Height	**No of Characters Per Line**	**No of Lines**
88 mm	29	12
100 mm	23	10
120 mm	21	8
135 mm	17	8
160 mm	15	6
182 mm	13	6

SMD - P 8 - 5 X 3		
Font Height	**No of Characters Per Line**	**No of Lines**
88 mm	52	12
100 mm	36	10
120 mm	32	8
135 mm	25	8
160 mm	22	6
182 mm	18	6


Don't Use Mobile While Driving
Wear Seat Belt Drive Safely
Wearing Helmet Saves Life
Follow Lane Discipline
Always Overtake from Right
Slow Down, Sharp Right Ahead

FONT HEIGHT 88 mm

FONT HEIGHT 100 mm

FONT HEIGHT 120 mm

FONT HEIGHT 135 mm

FONT HEIGHT 160 mm

FONT HEIGHT 182 mm

Fig. 8 Effect of Panel Size on Message displayed with different Font Size (E.g. SMD – P8 1x1 m)

8.1.4 *Limit Panels*

The limitations on the number of message panels to use are twofold:

a) Motorists should be able to read the message twice while traveling at the posted speed.

b) When more than two screens (panels) are used, the message and its order become confusing to the motorist. The message shall be kept to two panels, except as described below:

- The chain law, as three panels must be used to get all the pertinent information to the drivers as approved by the Traffic Engineer for safety or emergency reasons.
- Again, the average motorist at a high speed can comprehend two message panels. If three panels are necessary, keep the confusion minimized. Each panel should be a complete phrase and each phrase should be independent of the other. If the motorist begins reading the message at the 2nd or 3rd panel, the total message should make sense.

8.1.5 *Message Unit*

VMS legends must be suitable for all drivers to read and shall focus on providing information that benefits the largest number of customers using the road network. Research carried out in 2018 by the Transport Research Laboratory (TRL), has shown that drivers can recall on an average 4 to 5 pieces of information. Where possible a VMS legend should contain as few pieces of information as possible, with a maximum of 7 pieces. If it is necessary to convey more than this, then messages should be paired. However, based on the TRL research, the number of words used should be minimized as far as possible.

TRL's 2018 research also showed that when constructing legend, the LPEG order (location, problem, effect, and guidance) as given in **Table 7**, provides the most effective means of communicating succinctly with drivers, although not all 4 elements are required for every legend.

Table 7 LPED Order for Constructing a Legend

Location	Where is the problem?
Problem	What is the problem? (Accident/Major Event/Closed)
Effect	What has the problem caused? (Delays/Long Delays/45 MIN DELAY)
Guidance	What should be done? (Slow Down/Follow Diversion)

(courtesy:https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1008823/Variable_Signs_and_Signal_Policy.pdf)

8.1.6 *Font*

Except for smart motorway, the font shall be Transport Medium/Noto sans Mixed case.The size shall be 88 mm up to 182 mm and shall be used based on the content to be shown in VMS.

Exceptions: Urgent warnings shall remain in Transport Medium/Noto sans Upper case text such as:

- o SLOW DOWN
- o SLOW
- o ONCOMING VEHICLE

8.1.7 *Message Familiarity*

Message familiarity is another aid for a motorist's ability to understand a message. When information displayed to motorists is unusual, longer comprehension time is required. Common language is necessary. VMS should have the capability of displaying messages in regional language.

For comprehension of message, the following are suggested:

(i) Drivers face difficulty in corresponding calendar days to days in a week. For example, "TUES - FRI" is preferred over "OCT 1 - OCT 4".

(ii) Drivers find the phrase "FOR 1 WEEK" ambiguous. It is preferable to use "WED-TUES". Most drivers felt the term "WEEKEND" meant the work would begin Saturday morning and be complete by Sunday evening. It is recommended that times and days be used if the work begins on Friday and extends to Monday.

(iii) The highway or route numbers should display destinations. The number alone can be confusing to both local and external drivers.

(iv) A unit of information may be displayed on more than one line on the VMS.

8.2 Message Configuration and Management

Experience has shown there are three types of elements to use when messages fall under the categories of incidents and traveler information. These are discussed in successive sub-sections.

8.2.1 *Advisory Signs*

The advisory signs **(Fig. 9)** display real-time information about highway status and advise the best course of action. These will mostly be used for incidents. The advisory sign message should consist of the following:

- A problem statement (accident, road closure, construction, adverse weather, etc.)
- A location statement (details of location)
- An attention statement (addressing a certain group of audience)
- An action statement (what to do)

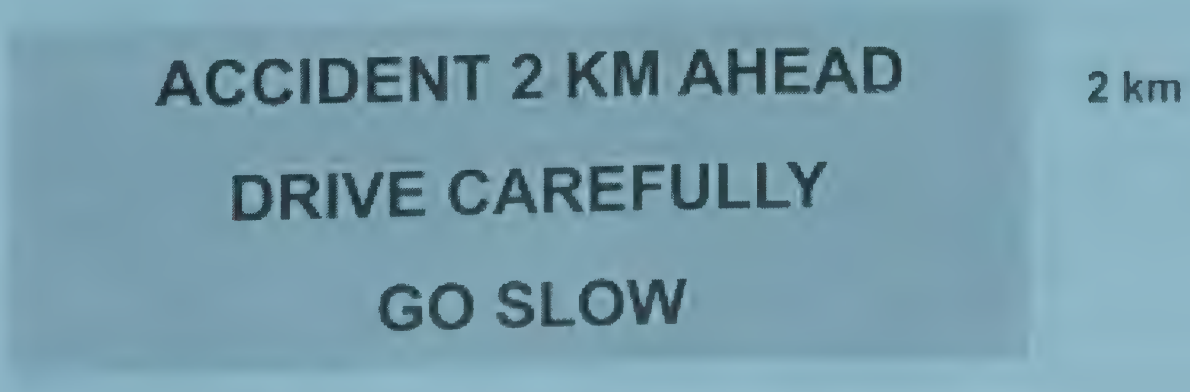


Fig. 9 Showing Message Load (information)

The message-load for the above is 4 units that is reaching the limit for an average person to understand while traveling at a high speed. The message length is the number of words or characters in the message. The average motorist traveling at a high rate of speed can handle eight-word messages of 4 to 8 characters per word, (excluding prepositions). The number of panels or frames is another important variable in the construction of a clear message.

The minimum information is the problem and action statements. The location of the problem is also sometimes useful in a diversion decision. E.g.

ROAD WORK AHEAD< Problem Statement SLOW DOWN < Effect Statement

HEAVY VEHICLES< Attention Statement MAY BE STOPPED< Action Statement

8.2.2 *Guide Signs*

Guide signs are necessary if the traffic must be diverted due to an incident or construction. The guide signs must provide destination information and route affirmation and direction.

8.2.3 *Advance Signs*

There are times to inform drivers of incidents that are further ahead of the current location. This up-to date information has the following basic elements that can be communicated:

Information alert

Nature of information (best route, traffic conditions, etc.)

Destination for which information applies

Location of the information (AHEAD or specific distance)

If there is a diversion situation with known alternative routes available. then route markers of the major alternative routes shall be provided well in advance with proper information alert.

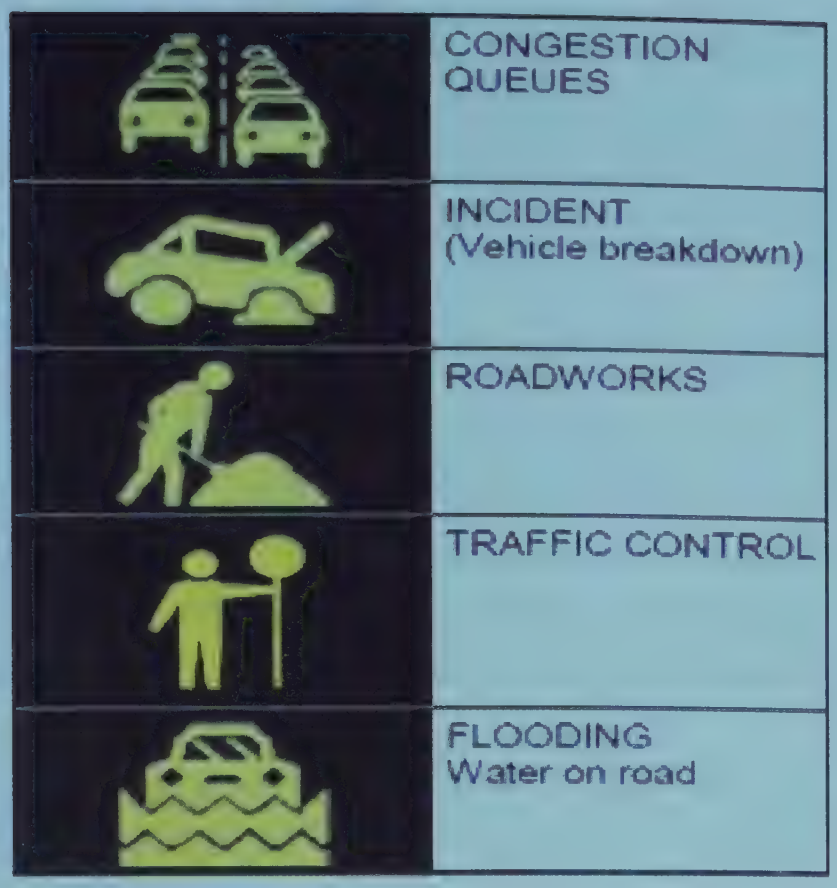
8.2.4 *Pictograms*

Graphical representation of the messages (or pictograms), either alone or in combination with alpha numeric word messages, is another way to display the messages. The standard symbols used on fixed signs in combination with short word messages can also be an option. Colour coding of the messages may also be useful to convey the message, for example an exit arrow in red may indicate heavy congestion at the exit, in yellow a moderate congestion and in green a free movement condition. Any of these display methods or any other innovation can be followed provided all the three elements of messaging, i.e., the 'information', 'location' and 'action' are clearly conveyed through the messages.

Pictograms shall only be used for tactical purposes and all tactical crash and incident pictograms must be shown within a red warning triangle. Tactical diversion route pictograms must not be shown with a red warning triangle and shall only be displayed at locations where fixed plate signs exist along the diversion route.

Unless a pictogram has more than one meaning, when used, the text the pictogram represents should be removed from any legends displayed on the VMS, unless doing so means no text will be displayed on the VMS.

Few examples are shown in **Fig. 10** on Pictograms for reference purposes. The text and the background color combination must ensure maximum visibility from the legible distance possible.



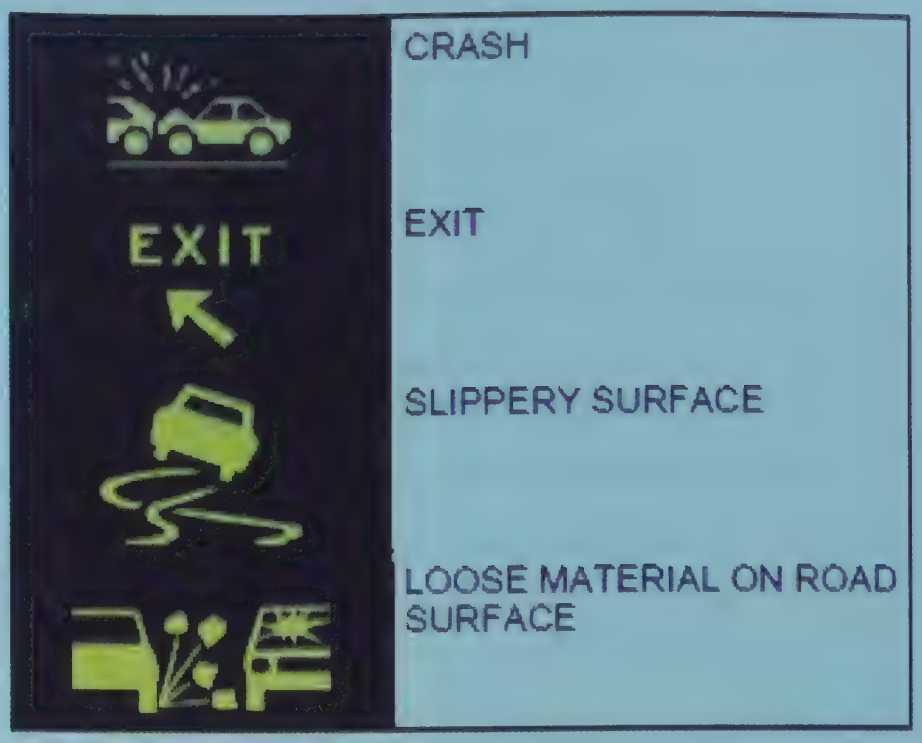


Fig. 10 Pictograms *(courtesy: Highway England)*

8.3 Performance Monitoring

VMS performance is primarily measured in terms of its availability defined as the measured uptime divided by the sum of measured uptime and downtime. Downtime is discounted for power and communication faults from service point which renders the ITS equipment unavailable for operations. Data as regards the availability of VMS unit shall be logged in the system from time to time and the same shall be reported on monthly basis. Availability of 98% is mandatory for the VMS devices.

9. VMS MAINTENANCE GUIDELINES

Maintenance of VMS includes the sign and all supporting components of the system and site. The requirements herein are for maintenance services relevant to a VMS site, so that they remain in good condition, operate as designed and meet the specified performance requirements.

9.1 Major Components at VMS Site

Major components which need maintenance at VMS site are listed below:

a) Variable Message Sign (VMS) unit as defined for all types, includes display enclosures, display LED boards, conspicuity devices, all associated electronics, electrical and mechanical components contained therein.

b) The Controller Cabinet is structure mounted, ground mounted, or integrated with other cabinets. It includes all control systems electronics, electrical and mechanical components contained therein.

c) Sign support steel structure for mounting of all types of VMS, includes all associated fixtures i.e., service platforms, handrails, meshes, brackets, fasteners, safety rails/cables/roller hooks, fixed lifting devices, fixed ladders, and surface treatments.

d) Externally mounted fixtures i.e., antennas, sensors or recording equipment installed onto VMS enclosure, sign support structure and controller cabinet.

e) Electrical power distribution system from service point of supply (metered/unmetered supply point) up to the VMS. It includes all power cables, switch devices, distribution devices, voltage conversion devices, stabilization devices, fuses, glands, connectors, surge protection devices and clamping fixtures.

f) Communication distribution system from the service point of supply up to the VMS, which includes all copper and fiber cables, routers, modems, splitters, converter patch boards, protection devices, glands, connectors, and clamping fixtures.

g) Power backup system (where provided), which includes auxiliary power generator, Uninterrupted Power Supply (UPS), Solar panels, battery(s) and charging units.

h) Site civil infrastructure, which includes concrete pathways, platforms, retaining walls, safety barriers, handrails, drains, landscaping.

i) Signage at site could be static post mounted, painted or labels,including site identification on controller cabinets, safety signs and pavement markings.

9.2 Maintenance Tool Kit

The list below is the 'Maintenance Tool Kit' which shall be considered by the maintenance inspector.

a) Work-Zone protection and traffic control equipment, including signs, traffic cones and flags.

b) Personal safety equipment, including hard hats, reflective high-visibility vests, goggles, face shields, harnesses (or belts), and lanyards.

c) Basic access equipment, such as a step ladder, extension ladder, and rope.

d) Tools for inspection, including chipping hammers, pocketknives, screwdrivers or awls, magnifying glass, magnet, flashlights, mirrors. The hammer is an excellent tool for testing

anchor rods. The mirror is for inspecting circumferential welds while climbing the truss. A magnet can confirm whether the material is steel or aluminum, as aluminum is nonmagnetic.

e) Tools for measuring, such as a plumb bob, levels, folding rulers, tapes, calipers, thickness gauges.

f) Wrenches, Allen wrenches, screwdrivers for removing access panels and bolt covers.

g) Torque wrench for bolt tightening or checking bolt tension.

h) Shovel and brush cutters.

i) Marking utensils such as lumber crayons or keel, paint sticks, soapstone, center punch.

j) GPS-recommended since many signs look similar, even sign panels, and are routinely replaced without complete notification to all parties.

k) Electronic devices for measuring vertical clearances are recommended.

l) Equipment to number the signs, either paint stenciling, adhesive tape, paint markers, etc.

m) Non-Destructive test equipment such as ultrasonic testing, dye penetrant, or magnetic particle.

n) Digital camera for documentation of maintenance.

9.3 Planned Maintenance

A combination of inspections/checks and preventative maintenance activities constitute planned maintenance to ensure continued serviceability and availability of a VMS asset.

Minimum planned maintenance inspection/checks are:

a) VMS display operation.

b) Condition of VMS enclosure, support structure, controller cabinet and other externally mounted accessories for damage, disfigurement (including vandalism), pealing or damaged galvanizing/paint surface coating and corrosion.

c) Presence of moisture, dirt, vermin/insects inside VMS enclosure, Controller cabinet, pits, exposed ducts, and steel structure crevices.

d) Wearing off or damaged site infrastructure i.e., concrete pathways, platforms, retaining walls, safety barriers, handrails, drains, landscaping etc.

A sample Planned Maintenance Service checklist for both checks/inspections and preventative maintenance items is given in **Annexure-G**.

Planned maintenance frequency will be 12 months.

9.4 Repairs and Incident Maintenance

9.4.1 *Fault Attendance Service*

The fault attendance service shall be available for twenty-four (24) hours per day, seven (7) days per week for attending to all VMS faults.

Typical causes of VMS faults include, but are not limited to:

(a) Sign Controller and associated equipment malfunctions,

(b) LED display failures,

(c) Conspicuity device failures,

(d) Power and communication equipment malfunctions,

(e) Power and communication cabling and wiring damage,

(f) Overheating of electronics inside sign and controller enclosures,

(g) Moisture or dust ingress,

(h) Accident damage,

(i) Storm damage, and

(j) Vandalism.

9.4.2 *Response Times for Fault Attendance*

Response time starts from the initial fault occurrence time stamp in the appropriate electronic Fault Management System or from the time of the fault call (whichever is earlier) and is the sum of following:

a) Remote investigation time to ascertain nature of defect(s)

b) Equipment/parts/materials preparation time, and

c) Travel time to site.

Response times for initial site attendance upon notification of a VMS fault is guided by the criterion as given in **Annexure-H**.

9.4.3 *Repair Time*

Repair time at site is the time taken to trouble-shoot the fault, completely repair the asset and make it available for service. Asset downtime directly affects operational availability. Swift, efficient and well-coordinated repairs will bring the asset back into operation quickly and will positively affect performance targets. Any abnormal delays, reasons for delayed repairs and estimate of the time required to complete the repairs shall be well notified to the stakeholders.

9.4.4 *Repetitive Failures*

If a fault requires call outs on three (3) occasions within a fourteen (14) day period, then root cause analysis shall be carried out to identify and implement appropriate actions to prevent recurrence of the fault. Where these actions recommend replacement or major renewal of the VMS asset, its proposal shall be submitted to the stakeholders based on a life cycle cost comparison of the proposal action. If stakeholders agree with the recommendations, then the renewal or replacement works shall be included in the next upgradation plan.

9.4.5 *Incident Support*

An Incident Support report should be raised when,

a) an incident is known to the team

b) an incident is informed by the TMC

c) an incident is informed by the relevant service provider

In the event of an incident, response time and repair time for reactive maintenance applies.

On-site attendance is required to:

a) assess whether the condition of the site poses any safety hazards to the public

b) prioritize and rectify all other faults and defects as a part of reactive maintenance

c) record the Incident details in the report

A format to record the incident is given in **Annexure-I**. Incident Support reports must be submitted as a part of the monthly report.

9.4.6 *Holding Stock*

At all times, the stock required for adequate minimum levels of parts and equipment to meet Planned Repair and Incident Maintenance shall be made available at site.

Contractor is to determine minimum stock levels for parts, equipment and materials based on VMS maintenance scope. An inventory of spares for parts, equipment, materials, and technical services is to be maintained by the contractor. Inventory is to be updated with minimum stock levels and holding stock periodically to match the VMS maintenance scope. Inventory of spares is to be updated for replacement parts and equipment, on approval by the respective authority.

9.4.7 *Disposal of Damaged, Defective, Obsolete or Redundant Parts and Equipment*

Due to maintenance or incidents, parts and equipment which are damaged, defective, obsolete, or redundant are required to be removed from the work site and disposed of. Such removal is to be done after formal information and agreement with the respective authority. Such parts and equipment are to be distinctly and permanently marked prior to disposal by indicating their condition.

Disposal of parts and equipment is to be done as follow:

a) Repair or refurbish the parts or equipment and hold them as spares in store for future use. For purposes of quality assurance, repaired or refurbished parts are to be treated the same as replacement parts and equipment. Their repair history is to be maintained and made available to the authority when requested.

b) Carry out disposal of parts and equipment that are Beyond-Economical-Repair (BER) by recycling. Items being disposed must be physically disfigured prior to recycling at a certified facility. Certificate of disposal must be provided.

9.5 Safety during Maintenance

It is highly recommended that every maintenance inspection program has a detailed safety plan submitted prior to work commencing. Maintenance inspections are one of the most hazardous types of inspections. They usually occur adjacent to live traffic. The sign structures are many times located at the 'gore' or exit areas of high-speed roads where work zone safety setups can be extremely difficult to set up.

In addition, it is routine that the inspector 'climb' the structure, which is complicated due to angled diagonals and slippery structural members. When climbing a sign or other ancillary structure a two layered system offers the best protection with one layer always secured to the structure. Good gripping boots, like the ones a mountain climber would use, are recommended. To perform a climbing inspection everything worn or carried by the inspector must be securely attached to him/her so nothing can drop or hang below the bottom of the structure.

The reporting of inspection findings may be handled by use of a radio attached to the inspector through which findings are related to a note-taker on the ground. Since the traveling public may be concerned when observing someone climbing a sign structure, a temporary message sign stating "**Workers Overhead**" as informational aid shall be installed prior to the work zone.

Listed below are typical contents of a safety plan:

a) Safety Plan Officer for Inspection firm

b) Safety Organization

c) Safety Incident Report Procedures and Forms

d) Fall Safety Specifications

e) Operation of Bucket or lift truck guidelines

f) Hospital and Police Station Locations

g) Specific work zone traffic setups for 'gore' areas/entry exit areas'

h) Mandatory personal safety equipment

i) First Aid Kit

9.6 VMS Failures

9.6.1 *Typical Failures in a VMS*

Typical VMS failures are given in **Table 8**.

Table 8 Failure Causes in a VMS

S. No.	Failures Cause
1	No display on the entire LED display (all black)
2	Garbled display on the LED display
3	Disordered or overlapped displaying of content on the entire LED display
4	Flickering/shaking display of content on entire LED display
5	No display on parts of the LED display
6	No display on a single cabinet
7	No display on a LED module
8	Black patch and module problem
9	Lines appearing on the screen
10	Wrong content displayed
11	Live content not displayed
12	Takes long time to change between screens
13	Uploading of emergency message taking long time
14	Media player is OFF
15	VMS Manager Dashboard Player not operational
16	Media Player Operating System corrupted
17	VMS client software corrupted
18	VMS smart manager portal issues

9.6.2 *Probable Failure Issues in a VMS*

Typical VMS related issues are given in **Table 9**.

Table 9 Failure Issues in a VMS

S. No.	Issue Cause
1	No AC power input
2	Media player is not powering on
3	Signal cable break down
4	Controlling system break down (sending card box)
5	Receiving card is not powering on
6	UPS is not working
7	LED studio setting mistake or signal cable connected wrongly
8	Controlling system breaks off (Sending/receiving card)
9	Wrong connection between cabinets/signal cable (flat cable) misconnected
10	Wrong voltage for controlling system
11	Ground wire break down
12	Loss of signal in signal command from media player to sending box
13	LED studio setting has problems
14	DVI card setting mistake
15	LED studio setting mistake or signal cable connected wrongly
16	Controlling system breaks off (receiving card)
17	Power supply break down
18	Signal cable connected wrongly
19	Wrong module input voltage
20	Input signal cable (flat cable) not connected well
21	Input signal cable (flat cable) break down
22	IC problem in module
23	Power supply not connected properly (no display on one corner of a cabinet)
24	Module break down or flat cable not connected well (Color missing on parts of module)
25	Receiving card issue
26	Wrong Playlist
27	Internet is down
28	Media Player application down
29	Unstable power with surges or fluctuations

10. ORGANIZATION

The utility of VMS is lost if the information is not updated in near real time. Updating information requires two types of activities, viz. the operation of a series of VMSs on the project road from the remote TMC, and secondly, intervention by various teams in response to the incident situation on ground. The in-house VMS operation at the TMC involves (a) running, operation and maintenance of TMC systems by experienced and qualified persons in the field of electronics/ electrical engineering or information technology, and (b) making traffic engineering and traffic management decisions by experienced and qualified persons in the field of highway or traffic engineering. As for response teams, these are to be drawn from various outside organizations like police, ambulance, medics, hospitals/trauma centers, maintenance and operation teams, road clearance teams, etc. The person in-charge of managing the TMC should be responsible for close coordination with these organizations on a real time basis.

Various organizations/stakeholders are associated to be a part of Traffic Management Centre (TMC) or Central Control Centre (CCC), such as NHAI, Traffic Police, Municipal Corporation, PWD, mobile/Wi-Fi service providers, utility service provider companies, etc. for the control and management of traffic movement, incident management, traveler information service, commercial vehicle management, electronic payment systems, safety services, emergency management services, etc. Organizational architecture refers to the engagement of various organizations/ stakeholders and defines and divides the involvement and role of various agencies within a system. When the works are distributed amongst all the agencies involved, it is also easy to find out the reasons for the failure of the system.

10.1 Management of TMC Organization

TMC is the hub of transport administration, where data is collected, analyzed, and combined with other operational and control concepts to manage the complex transport management network. It is the focal point for communicating transportation-related information to the media and the motoring public and is a place where agencies can coordinate their responses to transportation situations and conditions. Typically, several agencies share the administration of transport infrastructure, through a network of traffic operation and management centers. There is localized distribution of data and information, communication with traffic management centers which adopts different criteria to achieve the goals of traffic management. This inter-dependent autonomy in operations and decision-making is essential because of the heterogeneity of demand and performance characteristics of interacting subsystems. **Fig. 11** shows a concept of Traffic Management Control Centre.

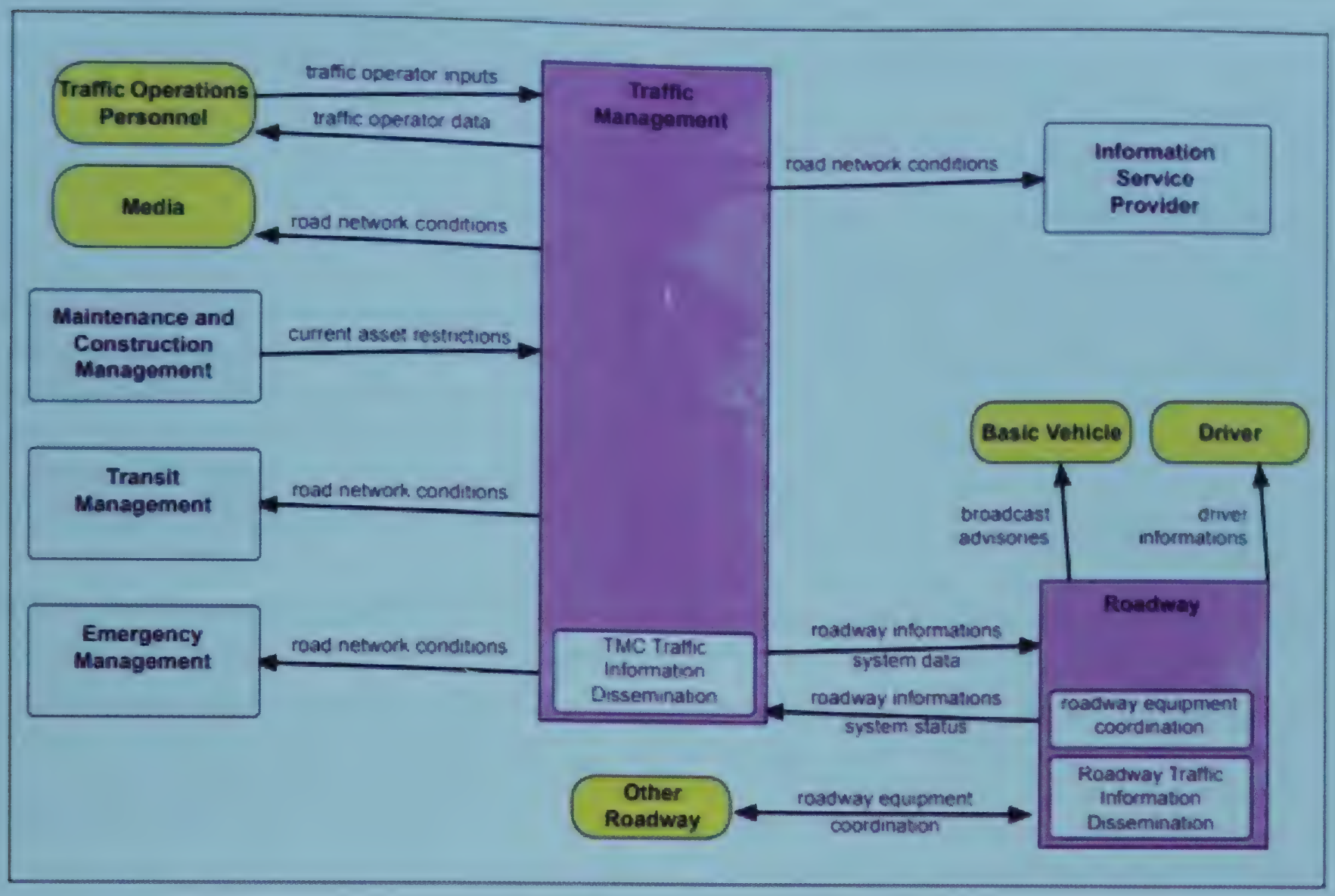


Fig. 11 A Concept of Traffic Management Control Center (ITS, 2008)

10.1.1 *TMC Managers*

TMC managers are responsible for developing an Operations Procedures and Guidelines Manual. The Manual will be a very useful document for staff working in the TMC. Responsibilities of TMC manager are listed in **Annexure-J**.

10.1.2 *VMS Operators*

The VMS operators should assist TMC managers and are often the critical link between the TMC and the motorists. They are the ones who ultimately control and monitor what is displayed on VMS. No matter how automated the VMS message posting practices, proper VMS operations require well-trained individuals to operate the system. Some of the desirable skills needed by operators and their responsibilities are listed in **Annexure-K**.

10.1.3 *Grouping Operations*

Some transportation agencies use an automation technique referred to as grouping. Grouping allows the TMC manager to place a certain number of signs into a group and associate a specific message with each sign so that when a single command is given by the VMS operator the messages on all the VMSs in the group change appropriately. This further simplifies system operations/management and helps keep incomplete or conflicting information from being displayed.

10.2 Management of Response Organization

Response organization is an organization who is responsible for management of hazardous

materials (Highway Patrolling and Maintenance Teams), the deployment of emergency medical services, and large and small-scale emergency response (i.e., Police and Fire-Brigade) and evacuation operations.

10.2.1 *Emergency Notification and Personal Security*

This service consists of two sub parts i.e.

(i) Driver and personal security (user-initiated distress signals):

For personnel security sub-service, GPS is used to transmit the location to the emergency personnel, repair service or the vehicle towing center. Vehicles which are pre-fitted with GPS trackers and sensors and connected to cloud data are easily tracked on this system. Private vehicles are normally not connected/not installed with GPS. However, the RFID Tags pre-installed in vehicles and the advent of e-tolling ensures that vehicles get tagged. It shall be easier to track and find vehicles through a well-defined network of RFID readers for surveillance.

(ii) Automated collision notification (automated notification of emergency personnel of the location, nature, and severity of the serious crashes):

For the automated collision notification sub-service, the communication is automatically sent through the installed sensors in the vehicle to the emergency helpline about the location of the vehicle where it met with a crash. Additional information about the condition and severity of the crash also gets transmitted based on the technology used. This emergency notification requires crash-sensing and GPS technology.

Performance requirements for emergency notification and personal security includes continuous real-time communication from appropriately equipped vehicles to at least one response unit. Minimum time should be taken in transmission and GPS tracking. The system should be both manual and automatic depending upon the severity of the crash or the requirement of the user. The system should monitor vehicle component conditions from inside the vehicle every few seconds and for critical emergency condition cases, this automatically sends appropriate distress signals.

To have this system in use, the main elements of the operation are in-vehicle GPS device for tracking vehicle position/location, a two-way communications link between the vehicle and the control center using commercially available smartphone service, and control center equipment for processing vehicle location, type of assistance required, and routing of the request to the appropriate response agency. The motorist will be notified of the action taken and the anticipated response time.

Private aggregators have launched disaster reporting apps which can be connected to central systems. User shall be able to see in real time the action taken, and the time/route taken by the first responder on the issue.

10.2.2 *Emergency Vehicle Management (EVM)*

The EVM service will provide for more efficient management and assignment of emergency response vehicles. Its intent is to reduce the amount of time between a public safety operator's notification on an incident and the arrival of emergency personnel at the crash location. This service will provide public safety agencies with fleet-management capabilities, route guidance, and signal priority and pre-arrangement for emergency vehicles.

This service consists of three subdivisions:

- Emergency vehicle fleet management
- Route guidance
- Signal priority

The primary users of all these services are police, fire, and hospitals. Real time reliable transportation and traffic information is required by this service to provide travel alternatives for the arrival of the emergency vehicle at the emergency site. Information on location of the incident and of emergency vehicles in the fleet is essential at the dispatch center. Emergency Vehicle Management (EVM) will identify the closest and most appropriate response vehicle, and transfer complete, accurate information on the nature and location of the incident to it.

Performance requirements developed till date indicate that the EVM should provide real-time information, offer vehicle identification with 99.9% accuracy within one minute of initiation and vehicle location with position accuracy within the range of 6-15 m. The system should also provide real time traffic signal prioritization by maintaining current information on signal timing, vehicle's location which is in emergency and its routing.

System architecture of the emergency response system is given in **Annexure-L**.

10.3 Requirements from Manufacturer/Vendor/Installer

Following shall be met:

- Company mark, standard followed, installation requirements, year of manufacture, certificate of wind load resistance up to 200 km/h for overhead installations.
- LED holding foundation and structure design drawing should be prepared by structural professionals and approved by experts in research labs, higher education institutions, and renowned consulting organizations, being a 3rd party accreditation.
- Placement of VMS should be finalized post initial survey ensuring least hindrance on visibility by tree branches, existing billboards, streetlight poles, high mast poles, overhead electric lines etc.
- Location should be finalized such that there will be least possibility of finding underlying utility during excavation.
- All the site activities should be performed under proper permissions from respective regional authorities.
- Excavation should preferably be performed manually to avoid utility damage in urban areas.
- Foundation should be strictly in line with the drawing specs and foundation bolts must be galvanized/red oxide coated to avoid corrosion.
- A minimum 2 weeks' time should be given to the foundation while curing so that the foundation can acquire required strength.
- Structural material should be MS steel or Galvanized iron depending upon the requirements.
- Safe space should be provided to climb and perform maintenance activities on the LED screen.
- VMS should be equipped with safety devices like, lightning arrester, surge arrester, earthing,

Circuit breaker/ELCB, to avoid electrical uncertainties and damage due to the same.

- Power and network cable must be armored, and on-site laying should be through proper HDPE Duct pipe.
- Junction box needs to be provided with IP65/IP67 with proper ventilation to provide protection for sensitive devices like Network switch-LAN connection, sim-based router, media player (CPU), UPS, sending box (content processing devices) etc.

The specifications for universal integration are given in **Annexure-M.** These are general, related to LED controller, media player and communication device.

11. APPROVAL OF NEW VMS SCHEMES

This section outlines the approval process for all new VMS installations so that the effectiveness of the proposed VMS scheme can be assessed prior to its procurement and installation.

The steps are:

1. Prepare a general requirement statement related to the proposed VMS
2. Identify the preferred location of the VMS
3. Assess the preferred location with respect to the usability, functionality, safety, and efficiency. If the location does not satisfy these criteria, then go to step 2 again.
4. Select the preferred VMS type
5. Specify the preferred VMS type
6. Approval application form shall be assessed by a committee for overall specification of VMS scheme. If found confirming to the requirements and criteria laid in this guideline, then proceed, otherwise go back to step 4.
7. Select the VMS message and check for message requirements and intended use. Amend it if found required, otherwise proceed forward.
8. Re-assess the VMS location, specification, and message against the general requirement statement. If found confirming then move to next step, otherwise re-examine starting from Step-1.
9. Identify the possible improvements, if any. If there are possible improvements then go back to Step-3, otherwise complete the VMS installation details, and move forward to complete the approval process.
10. VMS approval application form shall be placed to the approval committee. The certificate shall be attached mandatory with the work schedules. In case, the VMS installation has been proposed by the roads authority then the approval certificate will not be mandatory. However, complete responsibility of the possible consequences from installation of VMS will lie with the proposing roads authority.

All new legends/schemes shall be reviewed by a policy committee of IRC/MoRTH/City administration before placing them in use. The request for new legend shall include the following while conforming to the guidelines stipulated in this document:

(a) Exact wordings

(b) Situation where to be used

(c) The anticipated duration of display at a time

(d) The domain it supports – traffic management, safety etc.

(e) The existing legends which are not communicating the desired information

(f) The expected response from the driver

The policy committee shall examine, before giving approval, the following possibilities:

(a) Responsible organization

(b) Misinterpretation

(c) Confusion with respect to prevailing universal signages and messages

(d) Unwarranted distraction

(e) Safety issue or undesirable behaviour by a driver

(f) Political or commercial implications

(g) Interference with vehicular flow on road network

(h) Unwanted information

(i) Credibility and legibility of message

(j) Non-conformation with criteria stipulated in these guidelines

(k) Any other drawback

ITS ARCHITECTURE AND EXAMPLES

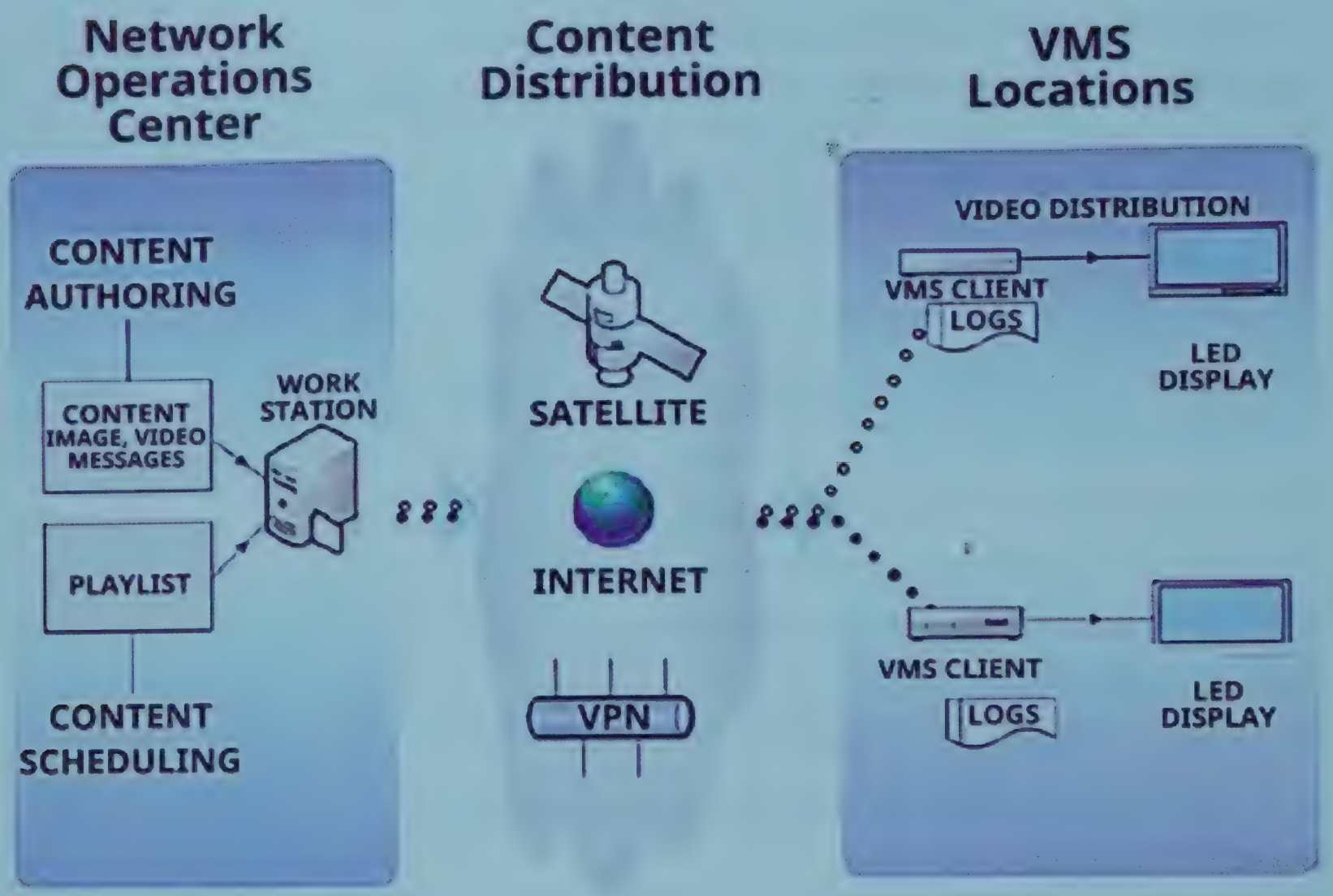


Fig. A1 Solution Architecture *(courtesy: H.780 (06/12))*

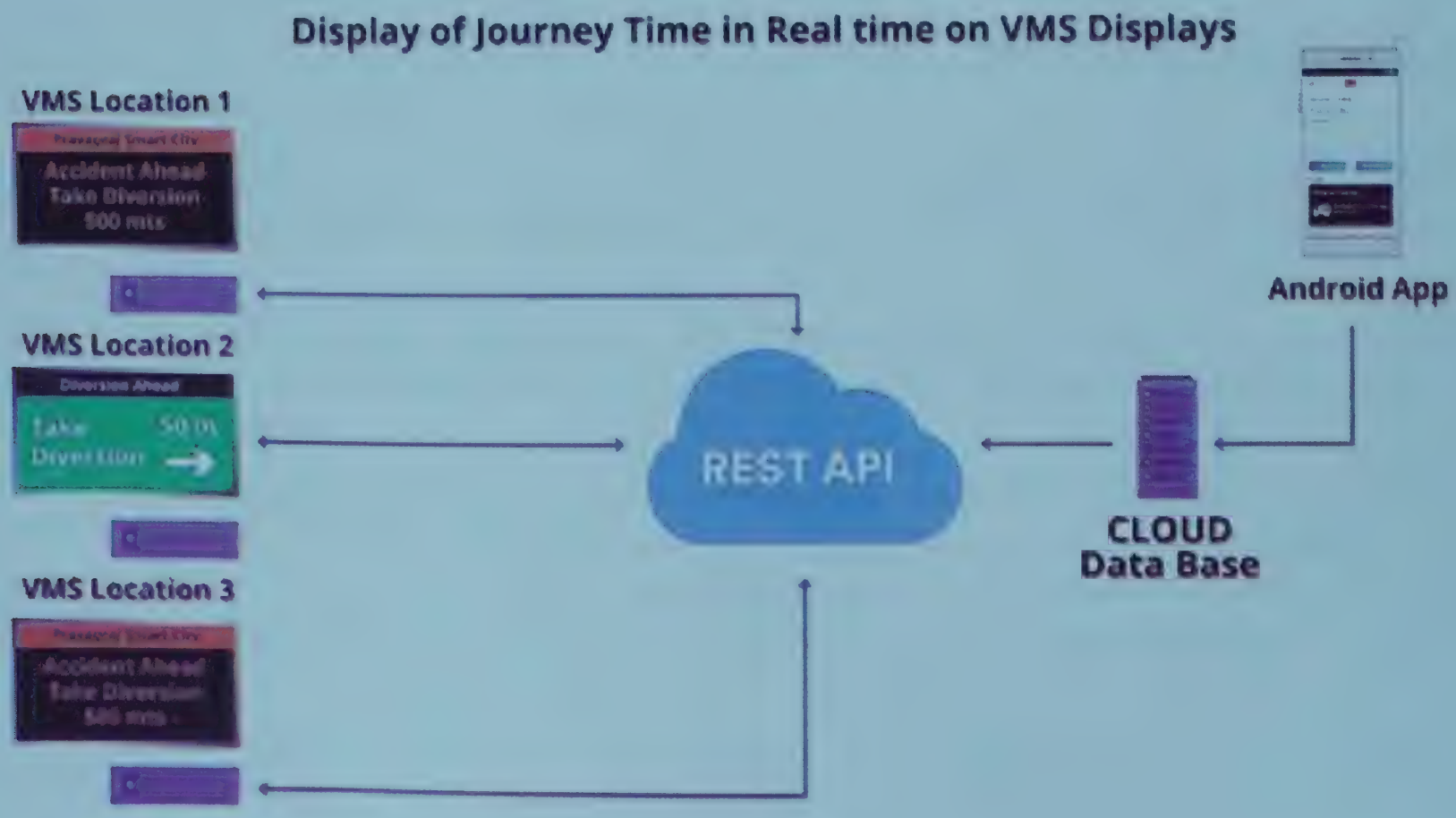
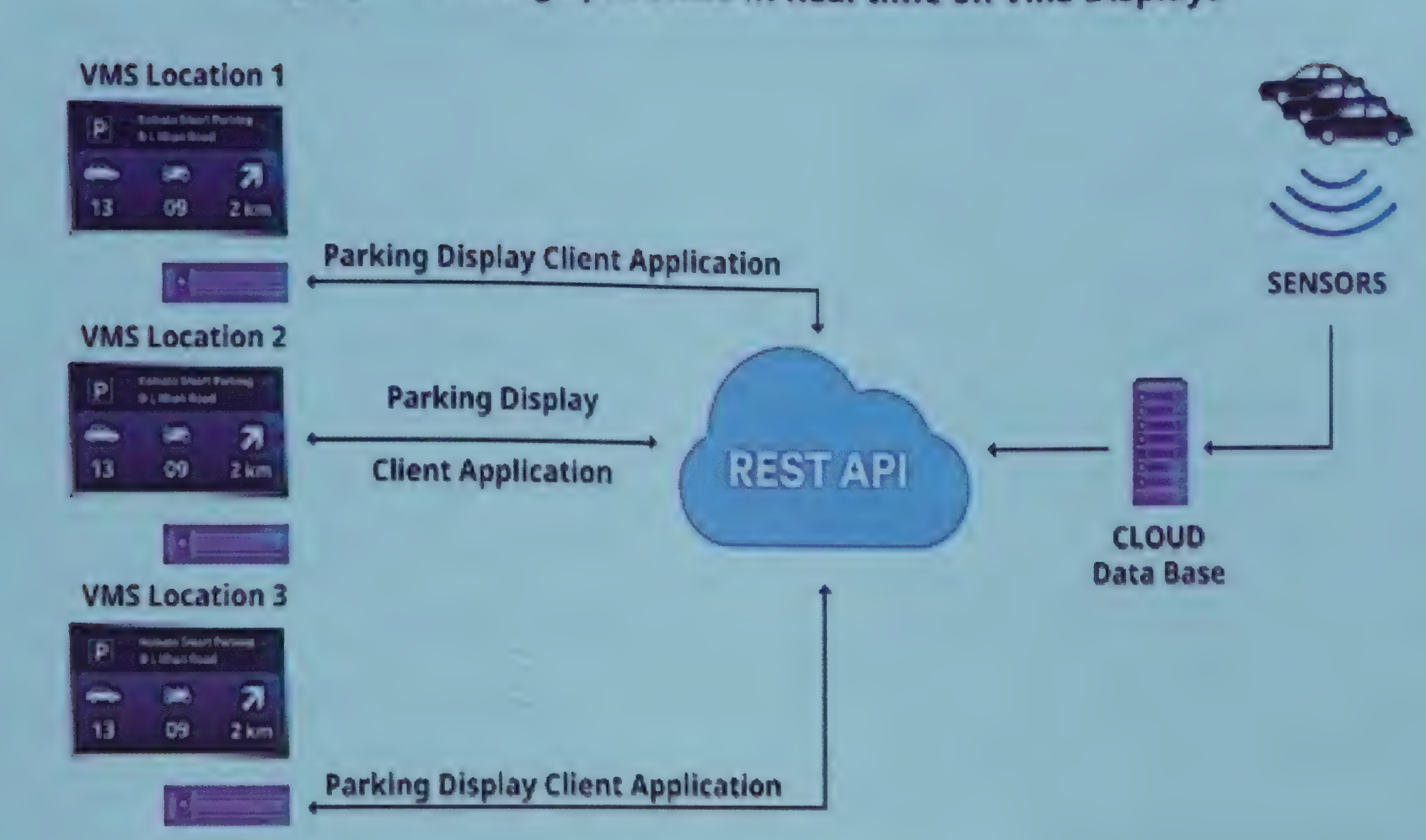


Fig. A2 Example ITS Architecture *(courtesy: H.780 (06/12)) (Cont.)*



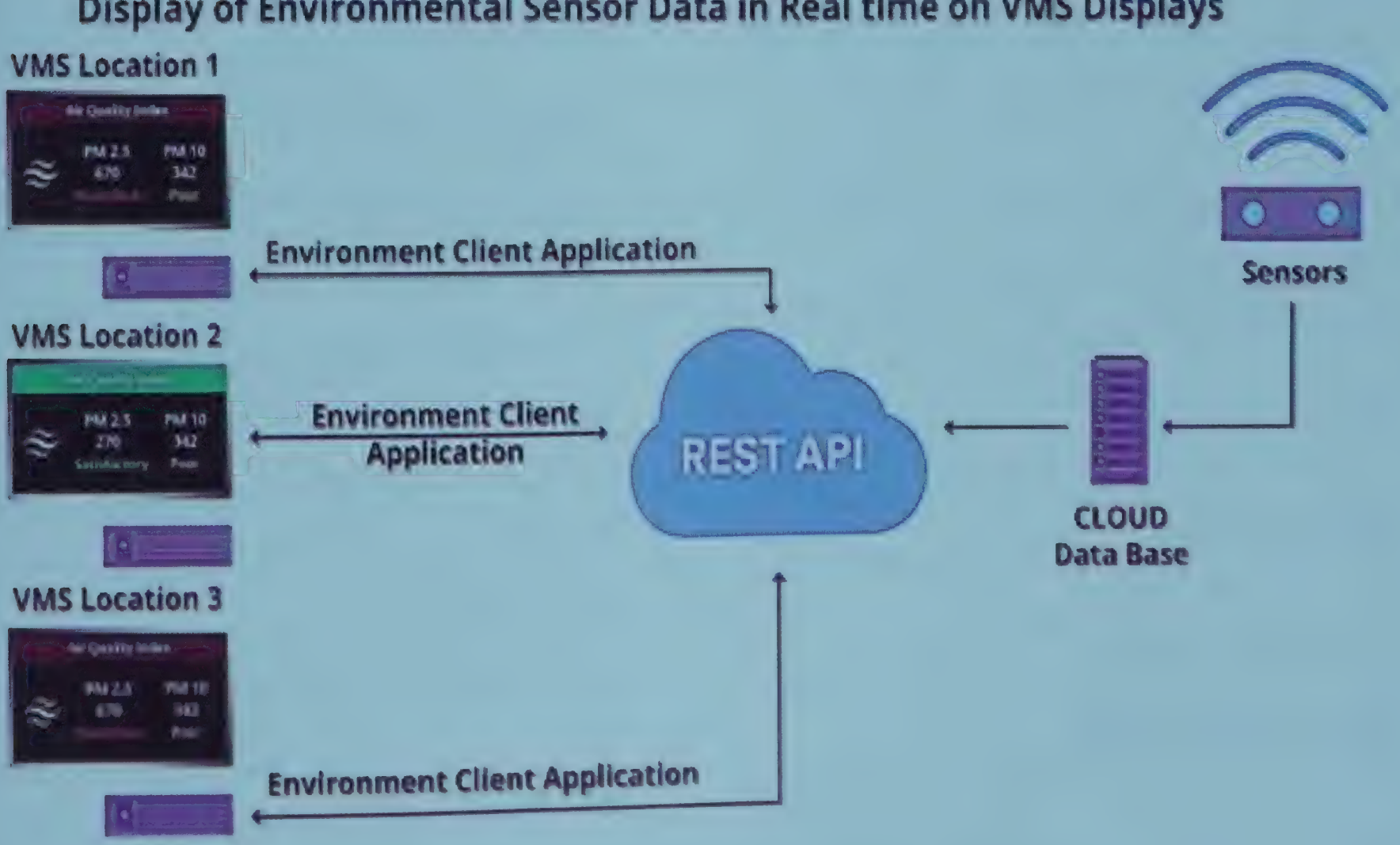


Fig. A2 Example ITS Architecture *(courtesy: H.780 (06/12))*

ANNEXURE-B

LIST OF STANDARD LEGENDS

CLOSURE RELATED:

ACCIDENT AHEAD ROAD CLOSED

EXIT CLOSED AHEAD

LEFT LANE CLOSED

LEFT SHOULDER CLOSED AHEAD

RAMP CLOSED AHEAD

RIGHT LANE CLOSED

RIGHT SHOULDER CLOSED AHEAD

ROAD CLOSED KM AHEAD

ROAD TEMPORARILY CLOSED

CENTER LANE CLOSED AHEAD

FRONTAGE ROAD CLOSED

LEFT LANE CLOSED AHEAD

RAMP CLOSED

REST AREA CLOSED

RIGHT LANE CLOSED AHEAD

ROAD CLOSED

ROAD CLOSED AHEAD

TUNNEL CLOSED AHEAD

CONSTRUCTION RELATED:

BRIDGE WORK AHEAD

CONSTRUCTION AHEAD EXPECT DELAYS

CONSTRUCTION NEXT ____KM

CRACK FILLING AHEAD

FRESH BITUMEN ON ROAD

MEDIAN WORK AHEAD

METAL PLATES AHEAD

MOBILE PATCHING AHEAD

MOWERS AHEAD

NIGHT WORK AHEAD

PAINT CREW AHEAD

PAVING OPERATIONS AHEAD

ROAD PAVING AHEAD

ROAD WORK AHEAD EXPECT DELAYS

ROAD WORK NEXT _____KM

ROAD WORKERS AHEAD

SHOULDER WORK AHEAD

SLOW MOVING VEHICLE

TRUCKS CROSSING

WATCH FOR TRUCKS

WETPAINT

WORKERS IN TUNNEL

DIRECTION RELATED:

ACCIDENT AHEAD ALL TRAFFIC MUST EXIT

ACCIDENT AHEAD BE PREPARED TO STOP

ACCIDENT AHEAD EXPECT DELAYS

KEEP LEFT

KEEP RIGHT

DELAYS

ACCIDENT AHEAD MERGE LEFT

ACCIDENT AHEAD MERGE RIGHT

ALL RAMPS OPEN

ALL TRAFFIC EXIT LEFT

ALL TRAFFIC MUST STOP

CHECK FUEL BEFORE ENTERING

CURVE AHEAD

DO NOT PASS

EXPECT DELAY

FORM ONE LANE RIGHT

FORM TWO LANES RIGHT

HEAVY TRAFFIC TO MOUNTAINS

LANE CONTROL AHEAD

LANE NARROWS AHEAD

LEFT 2 LANES CLOSED

ALL TRAFFIC EXIT

ALL TRAFFIC EXIT RIGHT

BUMP AHEAD

MERGE LEFT

MERGE RIGHT

CONGESTED AREA AHEAD

DETOUR

EXIT HERE

FORM ONE LANE LEFT

FORM TWO LANES LEFT

HEAVY TRAFFIC AHEAD

LANE CLOSURES AHEAD EXPECT

LANE ENDS

LANES MERGE AHEAD

LIMITED SIGHT DISTANCE

LOOSE GRAVEL AHEAD

MAX SPEED _____ KMPH

MERGING TRAFFIC AHEAD
NO PASSING

NO SHOULDER

ONE LANE BRIDGE AHEAD

PASS LEFT

PAVEMENT ENDS

PILOT CAR AHEAD

RIGHT LEFT 2 LANES CLOSED

ROCKS ON ROAD

SHARP CURVE AHEAD

SHOULDER DROP OFF AHEAD

SIGNAL NOT WORKING

LOOSE GRAVEL ON ROAD

MERGE AHEAD

MINIMUM SPEED _____ KMPH

NO WIDE LOADS

ONE LANE TRAFFIC

PASS RIGHT

PEDESTRIAN CROSSING

PREPARE TO MERGE

ROAD NARROWS AHEAD

ROUGH ROAD AHEAD

SHOULDER DROP OFF

SIGNAL AHEAD

SINGLE LANE AHEAD

SLOW TRAFFIC

SPEED LIMIT STRICTLY ENFORCED

STEEP GRADE

TWO LANE TRAFFIC AHEAD

UNEVEN PAVEMENT AHEAD

USE DETOUR

USE LEFT LANE

VEHICLES CROSSING

WATCH FOR STOPPED TRAFFIC

YIELD AHEAD

SOFT SHOULDER AHEAD

STAY IN LANE

STOP AHEAD

TWO-WAY TRAFFIC

UNMARKED LANES AHEAD

USE DETOUR ROUTE

USE RIGHT LANE

ROCKS ON ROAD

YIELD

FIRE RELATED:

EXTREME FIRE DANGER

TRUCKS RELATED:

BRIDGE WEIGHT LIMIT AHEAD

LOW BRIDGE AHEAD

LOWER RUNAWAY TRUCK RAMP OCCUPIED

RUNAWAY TRUCK RAMP

RUNAWAY TRUCK RAMP CLOSED

RUNAWAY TRUCK RAMP OCCUPIED

TRUCKS USE LEFT LANE

TRUCKS USE LOW GEAR

TRUCKS USE RIGHT LANE

LANES SHIFT AHEAD

WEATHER RELATED:

ADVERSE CONDITIONS AHEAD

FLOODED ROAD AHEAD

FOGGY CONDITIONS MAY EXIST

HEAVY FOG AHEAD

HIGH WIND RESTRICTION

VEHICLES MAY BE STOPPED

REDUCED VISIBILITY AHEAD

DENSE FOG AHEAD

FOG AND ICY CONDITIONS MAY EXIST

GUSTY WINDS AHEAD

HIGH WIND ADVISORY

HIGH WIND RESTRICTION HIGH PROFILE

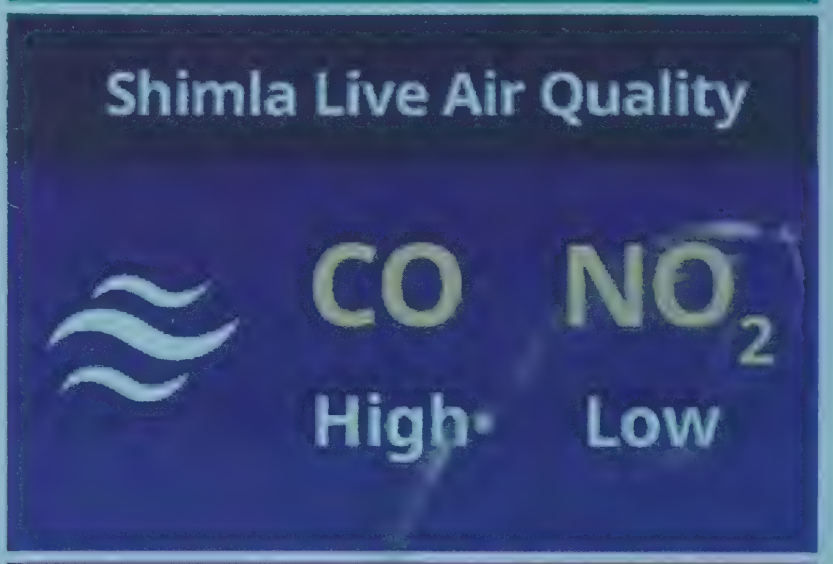
POOR VISIBILITY AHEAD

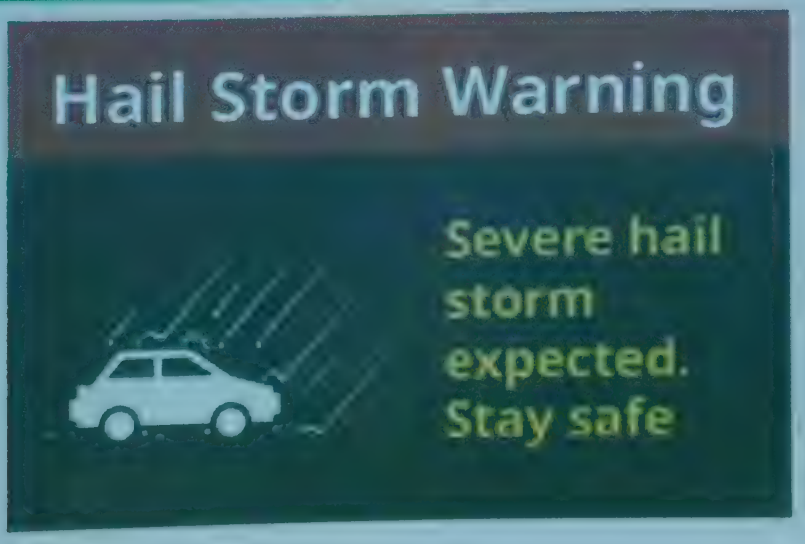
WATER ON ROAD

ANNEXURE-C

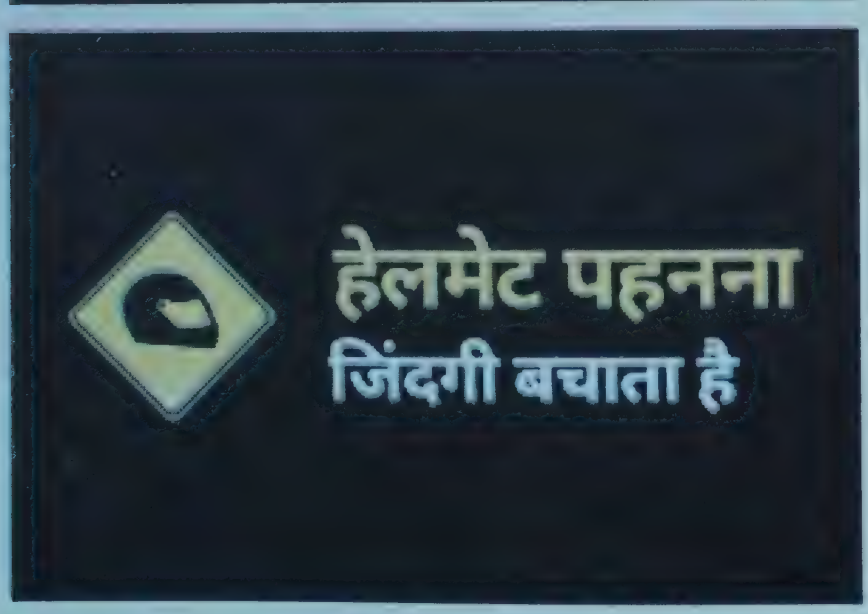
TENTATIVE DESIGN TEMPLATES

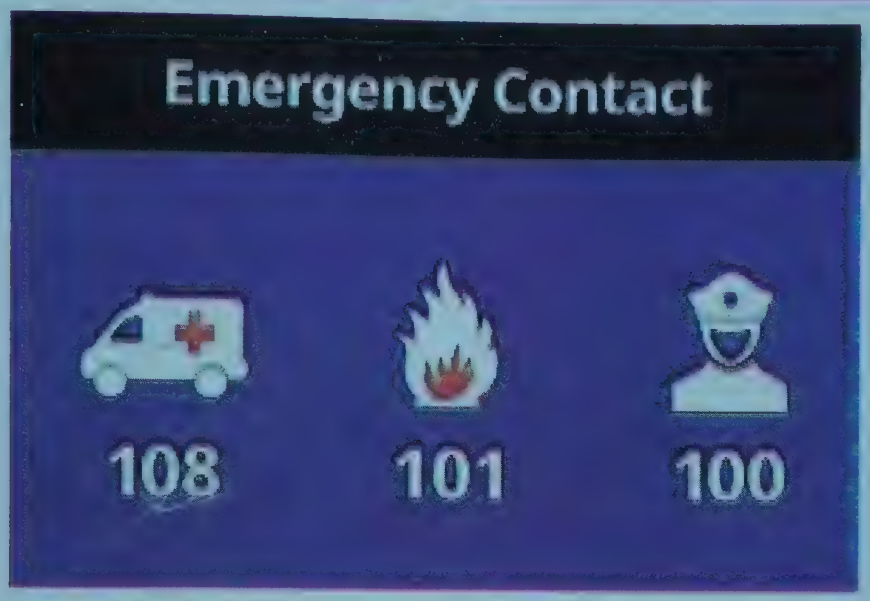
Traffic, Road and Weather Condition Information (3x2 meter)



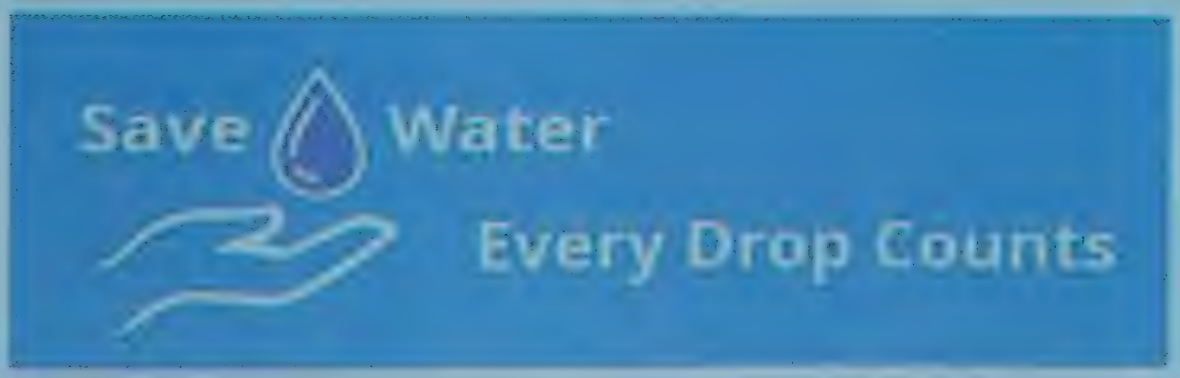


Safety Concern VMS (3×2 meter)





Social Concern VMS (3x1 meter)



Safety Concern VMS (3×1 meter)

Wearing Helmets
Saves Lives
Don't use mobile
while driving
Be safe. Always
wear a seat belt.
सुरक्षित रहें
हमेशा सीट बेल्ट पहनें
ड्राइविंग करते समय मोबाइल
फोन का उपयोग न करें
Do not drink
and drive
शराब पी कर
गाड़ी ना चलाएं

Safety Concern VMS (1x1 meter)

Social Concern VMS (1×1 meter)

Emergency Numbers VMS (1×1 meter)

Traffic, Road, Travel Time, Crash related VMS (2×2 meter)

Speed Limit
80
Max.
Speed
50 kmph

Speed Limit
50
Strictly
Enforced

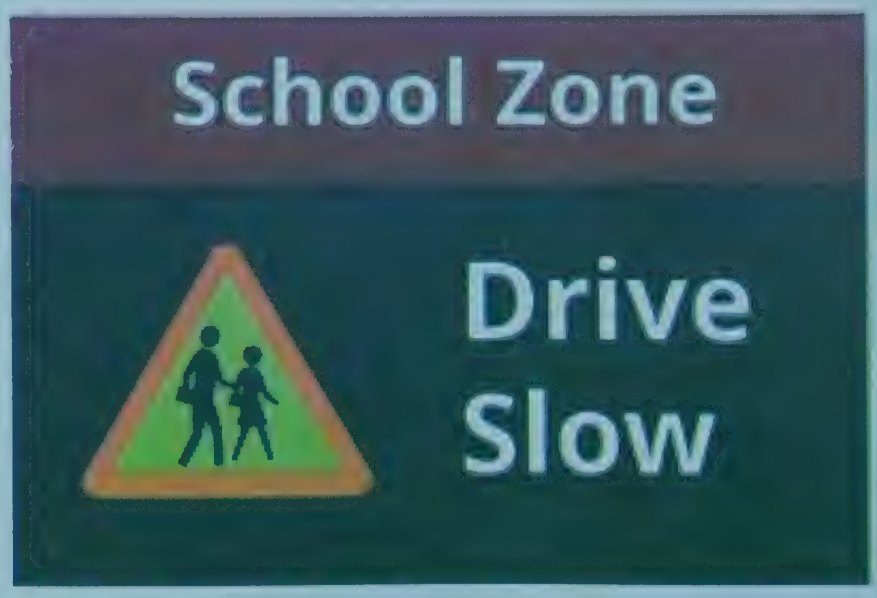
Merge Left

Congestion Area
Ahead

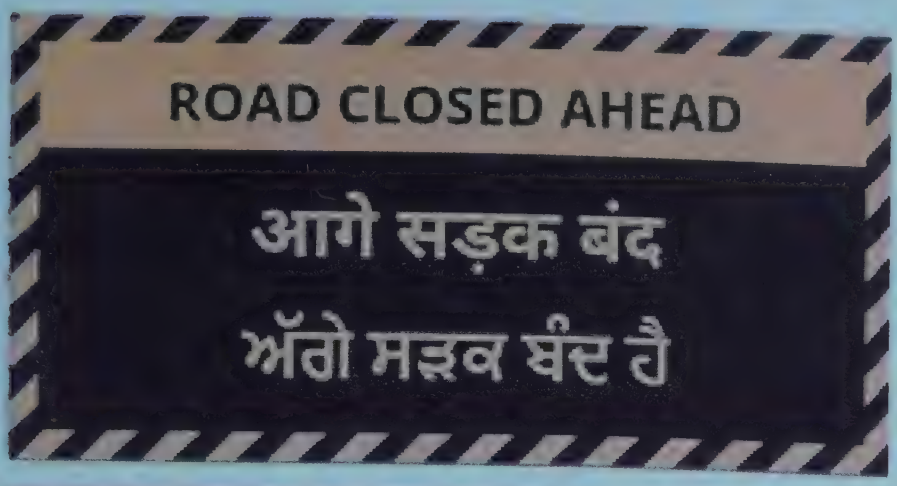
Merge Right

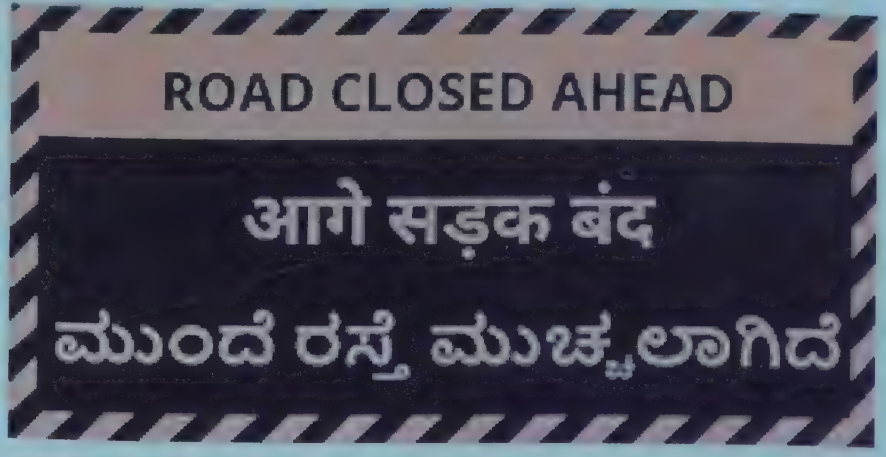
Accident Ahead
Road Closed

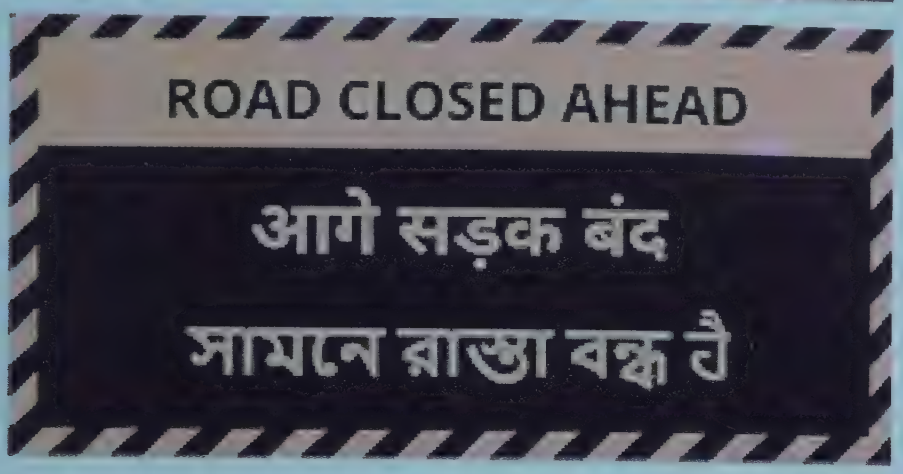
Speed Limit
50
Min.
Speed
50 kmph

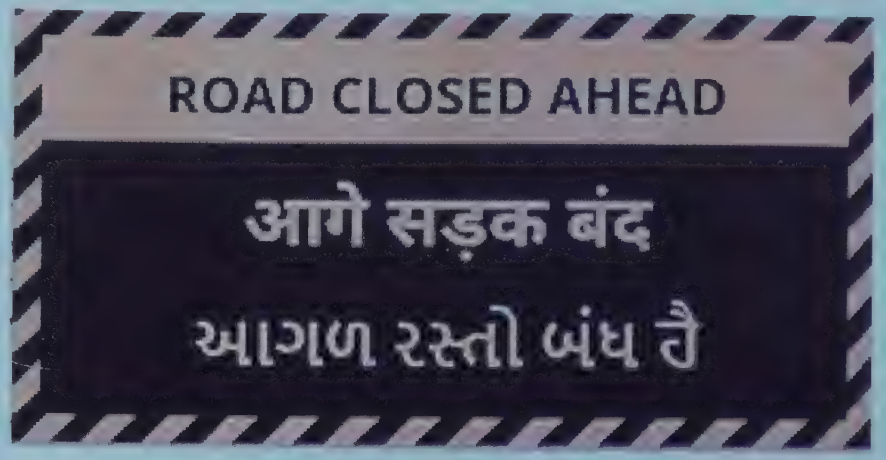

School Zone
Drive
Slow

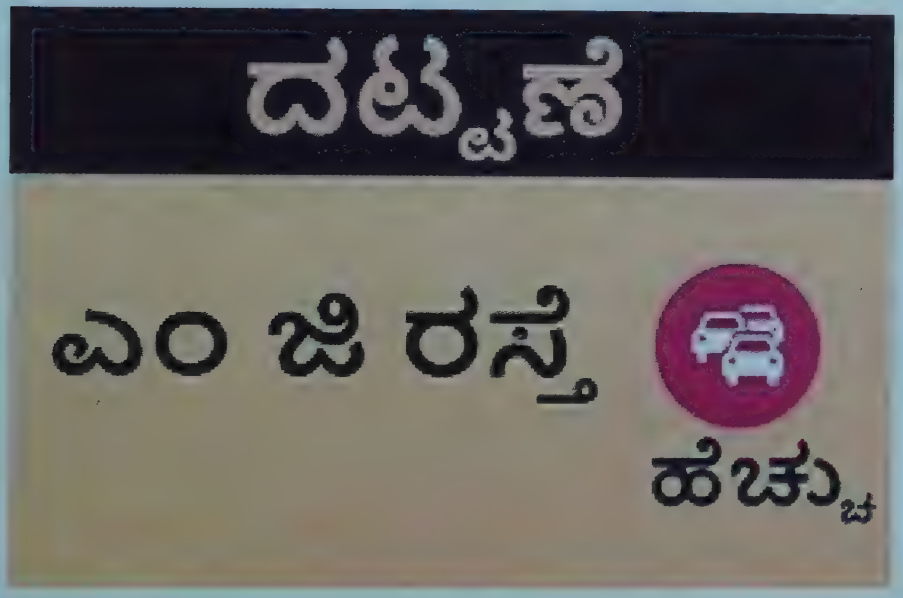
VMS in Other Languages

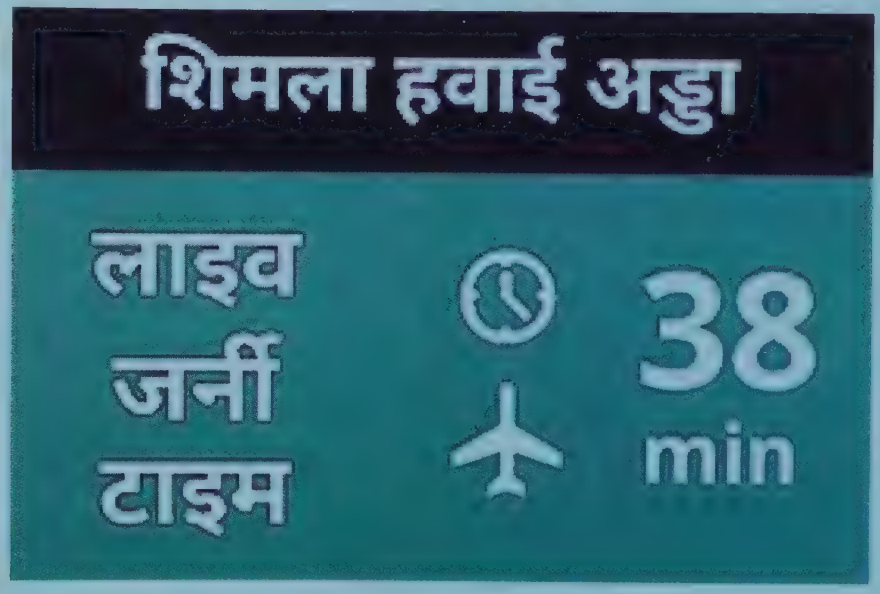












ANNEXURE-D

DESIGN STEPS FOR OVERHEAD GANTRY VMS (CANTILEVER AND SIMPLY SUPPORTED TYPE)

The VMS shall be mounted on support post, which may be of GI pipe conforming to IS 1239, Rectangular Hollow Section conforming to IS 4923 or Square Hollow Sections conforming to IS 3589. In case of signs supported on two or more posts, bracing may be provided.

Signs supports may be of mild steel, reinforced concrete (M25) or galvanized iron (GI Post) sections, ends shall be firmly fixed to the ground by means of properly design foundation.

A. Loads to be taken

- Dead Load: Self weight of structure needs to be taken.
- Wind Load: For wind load IS 875 Part-3 needs to be followed.
- Live Load: Walkway loading of 250 kg concentrated live load needs to be taken.
- Load Combinations: Different Load combinations can be adopted as per Clause 3.5 of IS 800.

B. Design of Members

- Vertical columns and horizontal beams can be designed directly using a software but if want to check manually then columns can be designed as compression members as per Clause 7.1 of IS 800 and beams can be designed as flexural members as per Clause 8.2 of IS 800.
- In Bolted Connections design bolts need to check for bearing and shear capacity as per Clause 10.3.3 and 10.3.4 of IS 800.
- In Welded Connections design for design of fillet welds Clause 10.5 of IS 800 needs to be followed.
- Base Plate should be designed as per Clause 7.4 of IS 800.
- Deflection Check needs to be shown for vertical and lateral cases respectively as per Table 6 of IS 800.

C. Design of Pedestal and Foundation

- The pedestal and foundation (open/pile) shall be designed for forces from the steel structure in accordance with IS 456/IRC:78.

D. Design Checks

(i) Check for Member (Top and Bottom Chord)

- Compressive Strength
- Tension Strength

(ii) Check for Member (Side Bracings)

- Compressive Strength
- Tension Strength

(iii) Check for Member (Top and Bottom Bracing)

- Compressive Strength
- Tension Strength

(iv) Check for Column (Vertical Post to Foundations)

- Axial Force (Compressive and Tensile)
- Bending Moment
- Shear Force
- Combined Shear and Bending Moment
- Combined Axial and Bending Moment
- Deflection

(v) Check for Connections

- Shear Force
- Tension Strength
- Combined Shear and Tension
- Bond Strength of Anchor Connections

(vi) Check for Base Plate

- Bearing Pressure
- Thickness
- Bending Moment
- Tensile Strength
- Bearing Strength

(vii) Check for Foundation and Pedestal

- One way Shear
- Two-way Shear
- Crushing failure for pedestal

ANNEXURE-E

FORMAT OF TESTS FOR VMS INSTALLATION

<<Name of Make>>

<<Model VMS.....>>

Variable Message Sign

Proof of Performance Test

Revision 1.0

(DDMMYYYY)

CERTIFICATION

Location: _____

VMS Model: XXXX **Serial No.** _____

Sign Control Unit Model: XXXX **Serial No.** _____

We hereby certify that this Variable Message Sign functions as per the test procedure in this document.

_____ _____

Tester (OEM) Witness (Authority)

Comments:

_____

_____

_____

_____

_____

_____

Date: _____

mm/dd/yyyy

STAND ALONE TEST

1.0 Equipment requirement

- Portable Terminal (Laptop PC).
- Null Modem Cable, Ethernet Cable.
- Led Master Software Application to exercise the VMS and SCU.

2.0 VMS System start-up

2.1 VMS

CHECK

(a) Record AC voltage coming to sign main breaker ..... [_____]

AC voltage must be between 207 to 253 VAC. (230 VAC +/- 10%)

(b) Switch on all circuit breakers. .....[ ]

This applies AC power to all circuits in the sign.

(c) Verify circulation fans are functioning. .....[ ]

All circulations fans are constantly running. They are not thermostatically controlled.

(d) Verify Exhaust fan is functioning. .....[ ]

The exhaust fan is controlled by a thermostat set to turn the fan on at 30°C. If the fan is off lower the turn on temperature by adjusting the dial on the thermostat until the fan comes on. Return the set point to 30°C after the test. If the fan is already running, then raise the set point until the fan turns off. Return the set point to 30°C after the test. If the Exhaust Fan control does not function the problem must be corrected before the sign is accepted.

(e) All PWR "RUN" indicators flashing. .....[ ]

This indicates each power supplies' diagnostic board is functioning.

(f) LCA Power Indicator ON. .....[ ]

This indicates the Logic Control Assembly hub is receiving power.

2.2 Sign Control Unit

(a) On/Off switch operation. .....[ ]

Press the red On/Off switch on the front of the SCU. In the "On" position the switch will remain depressed.

(b) Power indicator operation. .....[ ]

When the SCU is powered after the power switch is depressed the red indicator LED on the front of the controller lights up.

(c) Controller POST successful. .....[ ]

When the SCU power is switched on it first performs a Power On Self-Test (POST). This test takes approximately 60 seconds. If this test is successful, then the Liquid Crystal Display (LCD) on the front of the controller will display the time and date. If the test is not successful, then the LCD will remain blank. This problem must be corrected before testing can continue.

(d) System Status LCD displays time and date. .....[ ]

(e) SCU configured for VMS operation. ..... [ ]

Using the keypad on the front of the SCU, configure the controller for correct Drop Address, IP, Gateway, Mask and Remote Port configuration. The LOCAL COM port baud rate should be set to 115,200. Record the firmware version by pressing the * key on the keypad.

Firmware Version No. .....[ ]

Control Unit Address ..... [ ]

IP .....[ ]

Gateway .....[ ]

Mask ..... [ ]

Remote RS232 baud rate .....[ ]

Local RS232 baud rate .....[ ]

3.0 VMS OPERATIONAL TEST

3.1 VMS Test CHECK

A serial port on the Portable Terminal (laptop) is connected to the Sign Control Unit Local Comm port with a null modem cable. The Led Master application and the SCU are synchronized for Fonts, Messages, Controller Address, Communication Speed and Display Parameters.

(a) Launch the Led Master application. .....[ ]

The application is fully loaded and ready to use after the user logs in with the username and password. The factory default login-name is TECH and password is 123456.

(b) Navigate to the Diagnostics Page. ..... [ ]

(c) Activate the Pixel Test:

The Pixel Test will test each pixel in the sign for proper operation. Once the test is completed (about 30 seconds) a pop-up window will indicate how many pixels have failed the test. A graphical depiction of the sign will show where the failed pixels (if any) are located. A pixel will be marked as failed if it does not light up, is stuck on or its operating current is outside the range of 15 to 30 milliAmps. If there are any failed pixels, then the problem must be corrected before the sign is accepted.

No pixel errors .....[ ]

(d) Select Node Diagnostics:

The Node Diagnostic test uses OEM specific objects. The Node Diagnostic tests all the LED driver cards, power supply diagnostic cards, temperature sensor cards, fan sensor card and photo sensor card. If any card is deemed defective by the software, then it will be marked in red. A green indicator means the card is deemed operating normally. Any cards marked failed (red) must be corrected before the sign is accepted.

Click Refresh All button. ..... [ ]

All Nodes display green (No Errors). .....[ ]

(e) Select Sign Diagnostics:

The Sign Diagnostic uses standard NTCIP objects. Any indication other than No Errors indicates a fault in the sign and must be corrected before the sign is accepted.

(i) General Status: No Errors. .....[ ]

(ii) Controller Status: No Errors. .....[ ]

(iii) Internal temperatures (Celsius) displayed. .....[ ]

3.2 VMS Display Test CHECK

(a) Display a Static Test Message:

From the Messages window, select the test message "TESTING / TESTING / TESTING" showing on three lines of text and click "Display" to display the message on the sign.

(i) Message displays correctly. .....[ ]

(ii) Automatic Illumination Control Functioning. .....[ ]

(iii) Manual Illumination Control Functioning.....[ ]

The sign illumination control can be either automatic (sign brightness based on ambient light level detected by photo sensor) or manually set to one of 16 levels. Set the sign to manual brightness level 1 (this is very dim - night level) and observe the sign is very dim. This is done by selecting the "Manual" control and level 1 in the Illumination tab. Then set the Illumination control to Automatic and observe that the sign brightness increases according to ambient lighting conditions. The increase ramps up slowly and may take up to 5 minutes. If the Illumination control does not function the problem must be corrected before the test continues.

(b) Display a Multi-Page Message:

Page Control Functioning. .....[ ]

From the Messages window, select the test message "TESTING / TESTING / TESTING" showing on page one and “1234567890 / 1234567890 / 1234567890" showing on page two. Set the dwell times for page one to 5 seconds and for page two to 2 seconds. Click "Display" to display the message on the sign. The first page should display for 5 seconds, and the second page should display for 2 seconds. Use a stopwatch to verify the flash timings. If the Multi-Page message does not function the problem must be corrected before the test continues.

(c) Display a graphical test message using the Ethernet port. .....[ ]

This verifies the sign can display bit mapped graphics and the Ethernet port is functioning.

(d) Blank the Display. .....[ ]

Click the "Blank" button and observe the sign immediately blanks.

End of Test

Variable Message Sign (Spec No.)

Project Name _____ Ref. Drawings_____

Location _____ Date _____

ACTIVITY		DETAILS		REFERENCE	STATUS	COMMENTS
1	Preliminaries (pre-installation)	1.01	Verify gantry location, position and height	GFC drawings		
		1.02	Verify protection in place (barriers, guiderail, etc.)	GFC drawings		
		1.03	Verify lift points on VMS	OEM drawings and physical observation		
		1.04	Verify that connectors match-VMS to gantry	Physical test		
		1.05	Handhole, conduits to VMS gantry–confirm availability and clear path	GFC drawings and physical test		
		1.06	Verify galvanized anchors/nut-bolts	Physical test		
		1.07	Confirm availability of power and earthing	Physical test		
		1.08	Confirm traffic plan for road closure and compliance with local closure allowances	Coordination		
		1.09	Confirm adequacy of lifting equipment for lifting VMS in place	Coordination		
		1.10	Confirm availability of police/support vehicles to perform traffic control	Coordination		
		2.01	Lifting equipment in place			
		2.02	Traffic control coordinated			
		2.03	Install gantry	Installation manual		
		2.04	Install VMS	Installation manual		
		2.05	Route communication and power cables	GFC-wiring drawings		

2	**Installation**	2.06	Provide slack for the cables in the pull point	As recommended by Authority site supervisor		
		2.07	Verify lugs, ferrules, and cable labeling (at every 10 ft.)			
		2.08	Connect communication cable and power cable to VMS	As recommended by Authority site supervisor		
		2.09	Verify communications to central	As recommended by Authority site supervisor		
		2.10	Verify conduit sealing			
		2.11	Verify VMS is not displaying a message to motorists			
3	**POP Test**	3.10	Equipment ready for POP test	As per the format submitted by vendor		

FINAL VERIFICATION

	Name	Date	Signature	Remarks
Authority				
OEM				

ANNEXURE-F

FORMAT FOR QUALITY ASSURANCE PLAN FOR VMS

NAME OF COMPANY ADDRESS		
VMSB QUALITY ASSURANCE PLAN		
CLIENT : Various PROJECT : Miscellaneous	ITEM : Variable Message Sign Board System (VMSB) MANUFACTURER'S NAME : MODEL : LED Sign	QAP. NO.VMS/Gen/Pro/01 PAGE : 1 of 1 REV : 0 DATE : 04.07.2022

SR. No. 1	COMPONENTS/ OPERATIONS	CHARACTERISTICS	CLASS	METHOD OF CHECKING	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORDS	D	AGENCY	
										XYZ	C
	LED Display	Dimension	Major	Measure	Per Lot	FPS Variable Message Sign Boards.	FPS Variable Message Sign Boards.	Inspection report	√	P	R
	FRC Cables	Connector Type	Major	Visual	Per Lot	FPS Variable Message Sign Boards.	FPS Variable Message Sign Boards.	Inspection report	√	P	R
	SMPS - Energy Saving	Part Number & Qty	Critical	Visual	100%	FPS Variable Message Sign Boards.	FPS Variable Message Sign Boards.	Inspection report	√	P	RA
	LED Brightness	Brightness	Critical	Measure	100%	FPS Variable Message Sign Boards.	FPS Variable Message Sign Boards.	Inspection report	√	P	RA
	PCB	Receiving card & Monitor card	Critical	Visual	100%	FPS Variable Message Sign Boards.	FPS Variable Message Sign Boards.	Inspection report	√	P	RA
	Door Alarm	Sensor	Major	Visual	100%	Door open sensor	Door open sensor	Inspection report	√	P	R

	Display	Working Test	Critical	Visual	Per Lot	LED are working from the distance of 10-100 m	LED are working from the distance of 10-100 m	Inspection report	√	P	RA
	Looping LAN Cable	Make & length	Major	Visual/ Measure	100%	FPS Variable Message Sign Boards	FPS Variable Message Sign Boards	Inspection report	√	P	R
	Looping Power Cable	Make & length	Major	Visual/ Measure	100%	FPS Variable Message Sign Boards	FPS Variable Message Sign Boards	Inspection report	√	P	R
	Batch Number & BIS mark	Standard & BIS	Critical	Visual	100%	As Per BIS Standard	As Per BIS Standard	Inspection report	√	P	R
	Packaging	Standard Packing	Major	Visual	100%	Standard Packing	Standard Packing	Inspection report	√	P	R
	Assembly	At Site	Critical	Visual	Per Lot	FPS Variable Message Sign Boards	FPS Variable Message Sign Boards	Inspection report	√	P	H
	Accessories Box Material	Main LAN Cable	Major	Visual	Per Lot	Standard Packing	Standard Packing	Inspection report	√	P	R
		Main Power Cable	Major	Visual	Per Lot	Standard Packing	Standard Packing	Inspection report	√	P	R
		Connecting Clamp size	Major	Visual	Per Lot	Standard Packing	Standard Packing	Inspection report	√	P	R
		Bolts and Cap	Major	Visual	Per Lot	Standard Packing	Standard Packing	Inspection report	√	P	R
		Key for opening the door	Major	Visual	Per Lot	Standard Packing	Standard Packing	Inspection report	√	P	R

LEGENDS

RECORDS IDENTIFIED AS √ UNDER 'D', SHALL BE INCLUDED IN Q.A.P DOCUMENTATION
M = MANUFACTURER / SUB CONTRACTOR, C = CLIENT / TPI (THIRD PARTY INSPECTION AGENCY), P = PERFORM, W = WITNESS, R = REVIEW, TC = TEST CERTIFICATE , RA - REVIEW & APPROVE, H - HOLD IR = INTERNAL INSPECTION REPORT, D = DOCUMENT, IRN = INSPECTION RELEASE NOTE

Approved By Client

ANNEXURE-G

PLANNED MAINTENANCE SERVICER CHECK LIST

Check List of Preventive Maintenance Activity		
Project Name:		
Location Name:		
Date:		**Time:**
Sr No	**Maintenance Activities**	**YES/NO**
1	Cleaning of dust from inside the LED Cabinets (By Air Blower/Brush/Cloth)	
2	Dust cleaning of wing of Exhaust Fans used in Cabinets.	
3	Cleaning of Cooling Fans wings attached to SMPS.	
4	Cleaning of all RJ45 Male-Female connectors and Sending Box.	
5	Refixing/Reconnection/Replacement of all DVI/USB connections whichever are damage/loose connection in between Sending Box and Media Player.	
6	Refixing/Reconnection/Replacement of all RJ45 connections whichever are damage/ loose connection.	
7	Refixing/Reconnection/Replacement of all DC Power supply wire connections whichever are damage/loose connection.	
8	Refixing/Reconnection/Replacement of all type of flat cables connections whichever are damage/loose connection.	
9	Thin client (Media Player) keeps clean and put in under Nema Box.	
10	To check the Media Player auto rebooting condition and power adaptor.	
11	Need to check internet is working or not in b/w SIM based Router or LAN cable connection.	
12	NEMA box properly cleaned and closed	
13	UPS Power supply need to check from MCEB and Extension Board.	
14	Check Auto brightness card sensor and its working.	
15	Check receiving card connection and working.	
16	Check SMPS connection.	

ANNEXURE-H

RESPONSE TIME TO ATTEND THE VMS FAILURE

Type of Issue	Detailed Nature	Level	Response Time
Power Issue **Network Issue** Display not properly working No display on the entire LED display, all black, Garbled on the LED display, Flickering, shaking, Black patch, Lines appearing, No display	No AC power input, UPS is not working, Power supply break down,	**Level 1 (L1)**	Compliant registered at the helpdesk appointed by the customer, unique id to be generated; Basic Checks for Power, Network to be done. Issues Response time: 3-4 working hours after the issue has been registered.
	Ground wires break down, Power cable punctured, short circuit, leakage current, Voltage fluctuations.		
	Media player, sending box is not working, not powering on, replacement		
	Network cable punctured, Damage, Cut leakage, connector damage, Wrong connection between cabinets/signal cable (flat cable) misconnected		
	SMPS Failure, receiving card failure, Module failure, Loss of signal from sending box to VMS screen		
	LED studio setting mistake or signal cable	**Level 2 (L2)**	Onsite visit to be planned by the appointed service engineers at the customer's end, a diagnosis report shall be made. Response time: 5-6 working hours after the issue has been escalated to L2 Timings: 9:00 a.m. to 5:00 p.m.
	Reconfiguration of receiving cards and sending box		
	Disordered or overlapped displaying of content on the entire LED display		
	Network Port/USB port issue Port reconfiguration		
Software VMS client software corrupted, Smart manager portal issue, Media Player OS corrupted issue	Uploading of emergency message taking long time, not uploading	**Level 3 (L3)**	Remote Assistance shall be provided to the Local MSI teams same is for hardware trouble shooting guidance /assistance; IT infrastructure calibration, Central Server Integration Issues Response time: 12 working hours after the issue has been escalated to L3 Timings: 9:00 a.m. to 5:00 p.m.
	Reconfiguration of media player, data base.		
	New playlist is not downloading, not able to upload new content		
	Controlling system break down, corrupted, re configuration		
	Database Backup and Restore		

VMS Manager application, 3M VMS Client Application Support	New Integration with other 3rd Party Data providers	**Level 4(L4)**	If the issue identified at L3 is of Critical Fault and not resolved by Local MSI team, technical expert shall visit the site within 2 working days to assist in resolution; MSI teams to provide ground support for electrical / network support. All replacements or failures shall have back to bench support MSI to provide Storage for the spares; Spares for replacement shall be provided by 3M Response time: 48 working hours after the issue has been escalated to L4 Timings: 9:00 a.m. to 5:00 p.m. Annual Preventive Checks for Hardware
	Portal application, SSO Integration, Customized Reports		
	API development Integration and hosting, Database Management and Optimization		
	Updating in software		
	PORTS configuration for Database, API, and FTP Access		
	New Integration with other 3rd Party Data providers like Traffic Aggregators, Environmental Sensor Data		
	Data download issues between VMD clients and the ICCC Server		

ANNEXURE-I

FORMAT TO RECORD AN INCIDENT

INCIDENT REPORT

==========

Reported By: ..... Reported Time: .....

Title/Role: ..... Incident No.: .....

INCIDENT INFORMATION

Incident Type: ..... Date of Incident: .....

Location: ..... City: .....

State: ..... Pin Code: .....

Incident Description:.....

.....

.....

Name/Role/Contact of parties are involved

1.

2.

3.

4.

Reporting Officer Name..... Sign with Date.....

ANNEXURE-J

RESPONSIBILITIES OF TMC MANAGER

1. Operation of VMS system
2. Days and hours of operation
3. Controlling VMS Operators
4. Authority to design messages
5. Authority to display messages
6. Authority to display messages during off TMC hours
7. Requests for VMS messages from agency persons outside of TMC
8. Requests for VMS messages from other agencies
9. Documentation of VMS usage
10. Verifying the incident prior to displaying message
11. Verifying the message via CCTV
12. Message libraries vs. developing messages as the need arises
13. Automated display of messages
14. Automatic shutoff of VMS messages
15. Grouping operations of more than one VMS
16. Use of VMSs during construction
17. Use of VMSs during non-incident related conditions
18. Operation of VMSs with Lane Control Signals
19. Use of VMS messages as part of the highway management system operational strategies (along with ramp meters and traffic intersection signals)
20. Information needed about incident and alternative route before message is displayed
21. Priority of message types
22. Priority when two events (incidents, roadwork, etc.) are on the highway at the same time
23. Format of messages
24. Maximum number of units of information in messages for each VMS
25. Reducing message size when lighting conditions change
26. Reducing the number of units of information in messages to account for their effects on driver's ability to read messages
27. Messages displayed prior to identification of specifics of an incident
28. Acceptable message words/terms for

- Incident/Roadwork Descriptor
  - Use of the term CRASH rather than ACCIDENT
- Incident/Roadwork Location
- Closure Descriptor
- Location of Closure
- Effect on Travel
- Audience for Action
- Action

29. Acceptable abbreviation terms
30. Use of one-phase and two-phase messages
31. Use and criteria for flashing messages
32. Use and criteria for flashing a message line
33. Flashing beacons on VMSs
34. Messages after an incident is removed from the highway lanes before congestion clears
35. Messages after incident is removed from highway lanes after congestion clears
36. Location and positioning of VMSs
37. On-site control of VMSs
38. Coordination with other agencies
39. Display of congestion information during and immediately following incidents
40. Display of “all clear” messages after an incident has been removed from the highway lanes
41. Use of graphics in messages

ANNEXURE-K

SKILLS AND RESPONSIBILITIES OF VMS OPERATOR

Skills for VMS Operators:

- Common sense,
- Ability to make decisions under stress,
- Ability to understand and follow written and oral procedures,
- Writing and verbal abilities,
- People skills,
- Computer skills,
- General knowledge of transportation,
- Familiarity with local and state-wide roadway network,
- Technical knowledge, and
- Basic knowledge of electrical/electronics.

Responsibility of VMS Operator are as follows:

1. To understand the system, be able to make sound decisions, and quickly implement the proper procedures for routine and emergency actions, to assure the safety of the motoring public.
2. To provide quality information in a prompt and courteous manner to the public, and public agencies. When a situation arises which, the operator fails to resolve, the TMC manager or designer will be advised immediately, and a proper response will be provided as rapidly as possible.
3. To give timely and accurate notification to the proper agencies.
4. At the start of each shift, each operator will:
    - Discuss any ongoing incidents or issues with the operator going off-shift.
    - Access and read Email.
    - Scan all monitors to determine traffic conditions and verify the status of any incident.
    - Review closed incidents for the previous 24 hours on the Operator Workstation (OW).
    - Verify that the OW incident logs are completely up to date.
    - Make sure all customer inquiries received during previous shift have been handled.
    - If not, the off-shift operator should advise the incoming operator of any pending issues.
    - Ensure that, off-shift operator should leave the work area in a clean and orderly condition.

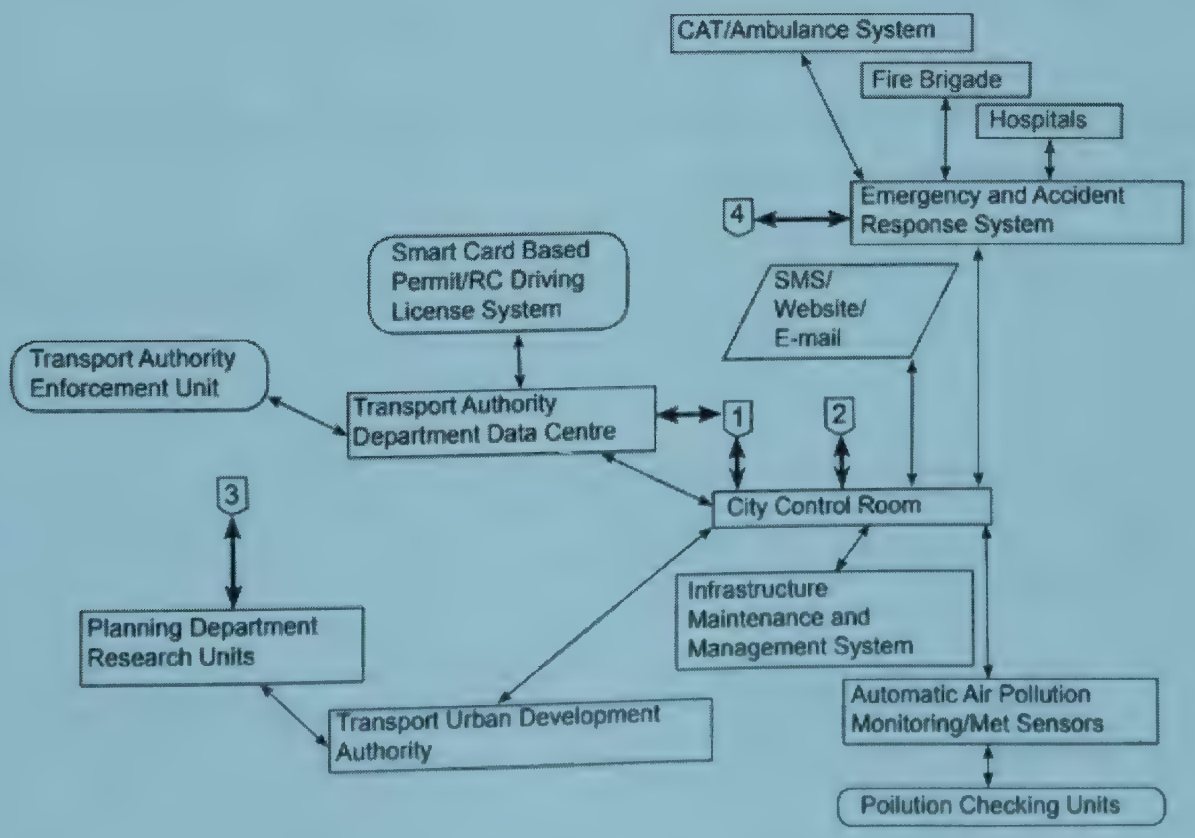
ANNEXURE-L

SYSTEM ARCHITECTURE OF EMERGENCY RESPONSE SYSTEM

There are several stakeholders to be included for effectively addressing the traffic management operation related to emergency situations. The purpose of bringing various stakeholders to one ITS architecture platform is to collect, exchange and disseminate the relevant information thus helping the travelers and operators with real time information for taking appropriate decisions.

The various stakeholders are:

- Ministry of Road Transport and Highways (MoRTH)
- National Highways Authority of India (NHAI)
- Public Works Department (PWD)
- Municipal Corporation
- Transport Authority
- Development Authority
- Planning Departments/Research units
- Police
- Traffic Police
- Highway Patrol
- Fire Brigade
- CAT-Ambulance System
- Hospitals
- Disaster Management Agency
- Environment-Pollution Control Department
- Courts



Above Fig. shows the System Architecture of Emergency Response System (IRC:SP:110-2017).

ANNEXURE-M

SPECIFICATION FOR UNIVERSAL INTEGRATION

1.	LED Type	DIP or SMD
2.	Pixel Configuration	1R/1G/1B
3.	Environmental grade	UV Resistant
4.	Color type	Real Full Color
5.	Best Viewing Distance	10 m - 150 m or more, Character size of 240 mm
6.	Control Method	Synchronized with System
7.	Frame Frequency	≥60 Hz.
8.	Grey Level	≥ 16K Grade
9.	Color Temperature	6000K-95000 K – DIP 3500K-9500K - SMD
10.	Humidity	10% to 90%
11.	Refresh rate	<=1920 hertz
12.	Defect Ratio	≤0.1%
13.	Working Voltage	AC230V±15%; 50Hz
14.	Video Interface	Supports RJ45 and DVI
15.	Communication	Wired through RJ45/Wi-Fi/SIM based router, NTCPIP compliant
16.	Life Span	1,00,000 HRS
17.	Viewing Angle	Horizontal >=120° / Vertical >=60°
18.	Functional features	The VMS boards shall have the facility to generate Real Time information of Traffic Data i.e., Traffic Live Congestion, Journey Time, Traffic rerouting, Live Weather, automatically using a site processor embedded system. The VMS solution should provide Android based application for Disaster Management and Emergency Messages
19.	Flat Cable, SMPS Voltage:	The System should be capable of showing the health status of FRC cable and SMPS Voltage etc.

Suggested Specifications for LED Controller, Media Player, and Communication Interface Device of VMS for Highway Application

Sr. No.	Typical LED Controller for Variable Message Display (VMD) System	
1.	Control Port	RS232
2.	Signal Input	DVI with resolution capability of 1920 x 1200 or better
3.	Signal Output	RJ45
4.	Maximum Load Capacity	2.3 million Pixels
5.	Input Voltage	100~240 VAC
6.	Operating Temperature	5~40 Deg C

Sr. No.	Typical Media Player for Variable Message Display (VMD) System	
1.	Media Player with built in Playout software	Should be of reputed manufacturers
2.	Processor	Standard manufacturer
3.	OS	Windows based

4.	Internal drive	60 GB Solid State Drive
5.	Output	HDMI/Display Port for Graphics
6.	Operating System Video	At least should support MPEG-4, WMV, QuickTime
7.	Audio	MP3, WAV
8.	Image	JPEG, PNG, BMP, GIF
9.	Text	Multiple fonts, Speeds, colors, animations
10.	Internet	HTML, XML Files, RSS newsfeeds
11.	Others Video Zones	1 or more
12.	Network	Ethernet 1000/100/10 (RJ45) and WIFI

Sr. No.	Typical Communication Interface Device for Variable Message Display (VMD) System	
1.	Ethernet Interface	
i.	Number of Ports	One 8 pin RJ45
ii.	Speed	10/100 Mbps, auto MDI/MDIX
2	Serial Interface	
i.	Number of Ports	One
ii.	Serial Standards	RS-232 on DB 9 connector
3.	Serial Communication Parameters	
i.	Data Bits	5, 6, 7, 8
ii.	Stop Bits	1, 1.5, 2
iii.	Parity	None, Even, Odd, Space, Mark
iv.	Flow Control	RTS/CTS and DTR/DSR (RS-232 only), XON/XOFF
v.	Baud Rate	110 bps to 230.4 kbps
4.	Serial Signals	
i.	RS-232	TxD, RxD, RTS, CTS, DTR, DSR, DCD, GND
5.	Software	
i.	Network Protocols	ICMP, IPv4, TCP, UDP, DHCP, BOOTP, Telnet, DNS, SNMP V1, ARP, HTTP, SMTP
ii.	Configuration Options	Web Console, Serial Console, Telnet Console, Windows Utility
6.	Physical Characteristics	
i.	Housing	Metal
ii.	Weight	340 g or less
iii.	Dimensions	With ears: 75.2 x 80 x 22 mm
7.	Environmental	
i.	Operating Temperature	0 to 55°C
ii.	Ambient Relative Humidity	5 to 95% (non-condensing)
8.	Power Requirements	
i.	Input Voltage	12 to 48 VDC
ii.	Input Current	128.7 mA @ 12 VDC

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(The Official amendments to this document would be published by the IRC in its periodical, 'Indian Highways' which shall be considered as effective and as part of the Code/Guidelines/Manual, etc. from the date specified therein)

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